

DRAFT

APPENDIX A

**REMEDIAL INVESTIGATION REPORT
RANDALL TEXTRON PLANT SITE
GRENADA, MISSISSIPPI
BASELINE RISK ASSESSMENT**

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A1.0 INTRODUCTION

This appendix presents the baseline risk assessment for the Randall Textron plant in Grenada, Mississippi. A discussion of site background, including a general site description, the history of waste disposal at the site, a summary of previous investigations, and the results of the current investigation was provided in the Remedial Investigation (RI) report.

This section gives an overview of the approach to the baseline risk assessment, describes the purpose of the baseline risk assessment, the guidance consulted, and how the baseline risk assessment is organized.

A1.1 OVERVIEW OF APPROACH

As described in the site Work Plan (ECKENFELDER INC., 1991), the public health and environmental assessment consists of a qualitative evaluation of the impacts to potential biological receptors, a quantitative assessment of human health risks in the absence of remedial actions (i.e., baseline), and development of risk-based action levels. Potential impacts to biota were qualitatively evaluated based on available information and site-specific observations, as described in the Ecological Assessment and Wetlands Survey (see Section 4.11 of the RI report). Furthermore, consistent with the site Work Plan, it was assumed that levels of constituents in site media which are protective of human health are also protective of the environment, so a quantitative characterization of environmental risks was not performed. It is believed that, if impacts to terrestrial or aquatic biota at or near the site were likely, the potential for these impacts would be indicated by the results of the soils, surface water, and sediment sampling efforts (see Section 5.0 of the RI report), and by the analysis of the physiochemical properties of the constituents of interest (see Section 6.1 of the RI report).

State Superfund, federal Superfund (CERCLA), and RCRA guidance documents were used in this baseline risk assessment (see Section A1.3). At the time that the site Work Plan was prepared, federal guidance on the development of risk-based action levels was not available. However, since that time, the USEPA has released the *Risk Assessment Guidance for Superfund - Volume I Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)*

(USEPA, 1991b). In addition, although the Mississippi Department of Environmental Quality (MDEQ) has a Superfund guidance document (MDEQ, 1990), it is considerably different from the current federal Superfund guidance with regard to risk assessment task descriptions and objectives. In fact, as stated in the MDEQ guidance, the risk-related activities described more closely resemble those set forth in the current federal RCRA Facility Investigation (RFI) guidance than the federal Superfund guidance. One reason for the difference in approaches is believed to be an effort on the part of the MDEQ to streamline the risk-related activities at state superfund sites, and to provide instruction for the gaps which existed in the current federal Superfund risk assessment process at that time (1990). However, since federal guidance is now available which is more recent and more site-specific than the MDEQ guidance, it was used as the primary source of methodologies in preparing the baseline risk assessment and risk-based action levels.

As described in the current MDEQ and federal guidance documents, a baseline risk assessment is conducted during the RI to quantitatively determine what potential risks to human health are presented by the site in the absence of any remedial action. Under the federal Superfund program, this risk assessment is a detailed, site-specific analysis, and results in risk estimates for potential human receptors. Conversely, as described in the current MDEQ Superfund and federal RCRA guidance, site risks are not actually calculated. Rather, potential receptors are identified, and a comparison of measured concentrations of site constituents to acceptable levels or target concentrations is performed. These levels may be based on existing standards or guidance, or may be calculated using simplistic exposure models, constituent-specific toxicity values, and standard exposure assumptions. However, the MDEQ's Superfund guidance does mention that a Responsible Party may conduct a site-specific risk assessment and propose exposure criteria based on that site-specific risk assessment. There is merit in both state and federal processes, but using one or the other does not completely characterize public health, risks, or develop action levels. Therefore, the risk assessment activities for the site were conducted in two phases: a baseline public health risk assessment to characterize risks in the absence of remediation; and the development of risk-based action levels.

In general, the baseline risk assessment was conducted in the following manner. Data collected during the RI were reviewed in terms of frequency, distribution, and types and concentrations of constituents present. Of the constituents present at the

site, a systematic process was used to select those of potential interest. An exposure assessment was then conducted for the constituents of interest in which potential migration pathways were characterized, and potential human receptors and exposure pathways were identified and quantified. A toxicity assessment of each of the constituents of potential interest was then conducted utilizing USEPA's on-line database, the Integrated Risk Information System (IRIS) and the Health Effects Assessment Summary Tables (HEASTs) (USEPA, 1993a). The final step of the baseline risk assessment was the performance of risk characterization using the data produced during the exposure and toxicity assessments. As part of the risk characterization, potential noncarcinogenic and carcinogenic risks to human receptors were quantified. Using the results and methodology for the baseline risk process, action levels were "back-calculated," assuming target risk levels.

A1.2 PURPOSE OF THE BASELINE PUBLIC HEALTH RISK ASSESSMENT

Prior to the consideration of potential remedial alternatives, a baseline public health risk assessment is conducted to provide an estimate of potential human health risks presented by the site in the absence of remedial action. The risk assessment is based primarily on data collected during the RI for the site. The baseline risk assessment provides: an understanding of the nature of hazardous substances releases at a site; potential pathways of human exposure; an assessment of potential risks presented by the site under baseline conditions; and other input valuable in developing remedial alternatives.

Both the State and federal programs require that remedial action objectives be established which specify the constituents and media of interest, potential exposure pathways, and target levels. The target levels are concentrations or ranges of concentrations of constituents for each medium of interest that are believed to provide adequate protection of human health and the environment. The target levels are initial levels to be further evaluated in the remedy selection process, along with chemical-specific "applicable or relevant and appropriate requirements" (ARARs) (see Section 6.2 of the RI report). Both the federal RFI and MDEQ guidance (September 1990) indicates that target levels for noncarcinogens should be at levels such that exposures present no appreciable risk of significant adverse effects to humans, and that target levels for carcinogens be set at concentrations corresponding to risks which fall within the range of 10^{-6} to 10^{-4} . The federal

Superfund process specifies that the 10^{-6} carcinogenic risk level shall be the "point of departure" for determining preliminary remediation goals (or action levels) for remedial alternatives. This means that a carcinogenic risk level of 10^{-6} is used as the starting point for determining the most appropriate risk level that remedial alternatives should be designed to attain, thus indicating the USEPA's preference for remedies on the more protective end of the risk range. Later in the remedy selection process, a decision will be made concerning the appropriate level of protectiveness, and preliminary action levels may be modified on the basis of exposure, uncertainty, or technical factors.

A1.3 GUIDANCE CONSULTED

The baseline risk assessment and risk-based action levels were developed based primarily on guidance set forth in the following documents:

- *The State of Mississippi's Guidance for Remediation of Uncontrolled Substance Sites in Mississippi* (MDEQ, 1990)
- *Risk Assessment Guidance for Superfund--Volume I, Human Health Evaluation Manual (Part A)* (USEPA, 1989a)
- *Risk Assessment Guidance for Superfund - Volume I, Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)* (USEPA, 1991b)
- *Interim Final RCRA Facility Investigation (RFI) Guidance* (USEPA, 1989)
- *Human Health Evaluation Manual Supplemental Guidance: "Standard Default Exposure Factors"* (USEPA, 1991a)
- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988)
- *Exposure Factors Handbook* (USEPA, 1989b)

In addition, specific risk assessment guidance from USEPA Region IV was used, the "Supplemental Region IV Risk Assessment Guidance" (USEPA Region IV, 1992).

A1.4 REPORT ORGANIZATION

This risk assessment is organized into the following sections:

- A1.0 - Introduction
- A2.0 - Selection of Constituents for Further Evaluation
- A3.0 - Exposure Assessment
- A4.0 - Quantification of Potential Exposures
- A5.0 - Toxicity Assessment
- A6.0 - Risk Characterization
- A7.0 - Risk-Based Action Levels
- A8.0 - References

As stated above, this risk assessment provides potential risk estimates using the most recent MDEQ and USEPA guidance for purposes of fulfilling the risk requirements of the site Work Plan. This assessment should not be used outside the stated context; it should not be used to represent actual risks to human receptors at or near the site. Furthermore, the assumptions made in this risk assessment typically have a conservative (i.e., err on the protective side) bias.

A2.0 SELECTION OF CONSTITUENTS FOR FURTHER EVALUATION

Details of the sampling program for the Randall Textron plant are presented in Section 3.0 of the RI report and the results of the sampling program are discussed in Section 5.0 of the RI report. For the purposes of the baseline risk assessment, summaries of the concentrations of constituents reported in various media sampled at the site are presented in the following sections. These media include: soils (Section A2.2), groundwater (Section A2.3), and surface water and sediment (Section A2.4).

A summary of all constituents reported in the Randall Textron plant media is presented in Table A2-1. This table presents the list of constituents for which samples were analyzed and an indication as to whether each constituent was detected in the medium of interest. The blank comparison conducted in Section 5.0 of the RI report is reflected in Table A2-1 in that a constituent for which all detections within a medium were X-qualified is not reported as a detected constituent. The detected constituents within each medium do however include detections at background locations. As discussed in Section 3.0 of the RI report, not all samples were analyzed for the entire range of analytical parameters. Selected samples from each medium were analyzed for the expanded list of constituents as presented in Table A2-1 (see also Tables 3-1 and 3-2 of the RI report), however, the majority of the samples were analyzed for the volatile organic compounds (or VOCs), and the selected inorganics, arsenic, chromium, lead, nickel and zinc.

Overall, Table A2-1 indicates that there were 68 constituents detected in the site media: 28 VOCs, 15 semivolatile organics, 1 pesticide, and 24 inorganics (including cyanide and hexavalent chromium). Fifteen constituents were prevalent throughout the site, and were detected in all site media, including five volatile organics and ten inorganics. These constituents are: methylene chloride, acetone, 1,2-dichloroethene (total), trichloroethene, xylene (total), arsenic, calcium, chromium, iron, lead, magnesium, nickel, potassium, sodium, and zinc. Calcium, magnesium, potassium, and sodium were not retained as constituents of interest in any media per the RI data evaluation on the basis of comparison to background concentrations and/or on the basis that these constituents are common major ions (see Section 5.0 of the RI report).

TABLE A2-1

SUMMARY OF SITE CONSTITUENTS ANALYZED^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Analytical Parameters	Site Soils	Site Groundwater ^b	Site Surface Water	Site Sediment
VOLATILE ORGANICS				
Chloromethane	X ^c	--d	--	--
Bromomethane	--	--	--	--
Vinyl Chloride	X	X	X	--
Chloroethane	--	--	--	--
Methylene Chloride	X	X	X	X
Acetone	X	X	X	X
Carbon Disulfide	--	--	--	--
1,1-Dichloroethene	--	X	--	--
1,1-Dichloroethane	--	X	--	--
1,2-Dichloroethene (total)	X	X	X	X
Chloroform	X	X	--	--
1,2-Dichloroethane	--	X	--	--
2-Butanone	X	--	--	--
1,1,1-Trichloroethane	X	X	X	--
Carbon Tetrachloride	--	--	X	--
Vinyl Acetate	--	--	--	--
Bromodichloromethane	--	--	--	--
1,2-Dichloropropane	--	--	--	--
1,3-Dichloropropane	--	--	--	--
Trichloroethene	X	X	X	X
Dibromochloromethane	--	--	--	--
1,1,2-Trichloroethane	X	X	--	--
Benzene	X	X	--	--
Trichlorofluoromethane	--	--	X	--
2-Chloroethylvinyl ether	--	--	--	--
Bromoform	--	--	--	--
4-Methyl-2-Pentanone	X	X	--	--
2-Hexanone	X	--	--	--
Tetrachloroethene	X	X	--	X
1,1,2,2-Tetrachloroethane	X	--	--	--
Toluene	X	X	X	--
Chlorobenzene	--	X	--	--
Ethyl Benzene	X	X	--	--
Styrene	X ^e	--	--	--
Xylene (total)	X	X	X	X
1,2-Dichlorobenzene	--	X	--	--
1,3-Dichlorobenzene	--	X	--	--
1,4-Dichlorobenzene	--	X	--	--

TABLE A2-1 (Continued)

SUMMARY OF SITE CONSTITUENTS ANALYZED^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Analytical Parameters	Site Soils	Site Groundwater ^b	Site Surface Water	Site Sediment
SEMIVOLATILE ORGANICS				
Acenaphthalene	--	--	--	--
Acenaphthylene	--	--	--	--
Anthracene	--	--	--	--
Benzidine	--	--	--	--
Benzyl alcohol	--	--	--	--
Benzo(a)anthracene	--	--	--	--
Benzo(a)pyrene	--	--	--	--
Benzo(b)fluoranthene	--	--	--	--
Benzo(ghi)perylene	--	--	--	--
Benzo(k)fluoranthene	--	--	--	--
bis(2-Chloroethoxy)methane	--	--	--	--
bis(2-Chloroethyl)ether	--	--	--	--
bis(2-Chloroisopropyl)ether	--	--	--	--
bis(2-Ethylhexyl)phthalate	--	X	X	X
4-Bromophenyl phenyl ether	--	--	--	--
Butyl benzyl phthalate	--	--	X	--
2-Chloronaphthalene	--	--	--	--
4-Chlorophenyl phenyl ether	--	--	--	--
Chrysene	--	--	--	--
Dibenzo(a,h)anthracene	--	--	--	--
3,3-Dichlorobenzidine	--	--	--	--
Diethyl phthalate	X ^e	--	X	--
Dimethyl phthalate	--	--	--	--
Di-n-butyl phthalate	--	--	--	--
2,4-Dinitrotoluene	--	--	--	--
2,6-Dinitrotoluene	--	--	--	--
Di-n-octyl phthalate	--	--	X	--
1,2-Diphenylhydrazine	--	--	--	--
Fluoranthene	--	--	--	X
Fluorene	--	X	--	--
Hexachlorobenzene	--	--	--	--
Hexachlorobutadiene	--	--	--	--
Hexachlorocyclopentadiene	--	--	--	--
Hexachloroethane	--	--	--	--
Indeno(1,2,3-cd)pyrene	--	--	--	--
Isophorone	--	--	--	X
Naphthalene	X	X	--	--
Nitrobenzene	--	--	--	--

TABLE A2-1 (Continued)

SUMMARY OF SITE CONSTITUENTS ANALYZED^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Analytical Parameters	Site Soils	Site Groundwater ^b	Site Surface Water	Site Sediment
n-Nitrosodi-methylamine	--	--	--	--
n-Nitrosodi-n-propylamine	--	--	--	--
n-Nitrosodiphenylamine	--	--	X	--
Phenanthrene	--	X	--	X
Pyrene	--	--	--	--
1,2,4-Trichlorobenzene	--	X	--	--
4-Chloroaniline	--	--	--	--
2-Methylnaphthalene	X	X	--	--
2-Chloronaphthalene	--	--	--	--
2-Nitroaniline	--	--	--	--
3-Nitroaniline	--	--	--	--
Dibenzofuran	--	--	--	--
4-Nitroaniline	--	--	--	--
2-Chlorophenol	X ^e	--	X	--
2,4-Dichlorophenol	--	--	--	--
2,4-Dimethylphenol	--	--	--	--
4,6-Dinitro-2-methylphenol	--	--	--	--
2,4-Dinitrophenol	--	--	--	--
2-Nitrophenol	--	--	--	--
4-Nitrophenol	--	--	--	--
4-Chloro-3-methylphenol	--	--	--	--
Pentachlorophenol	--	--	X	--
Phenol	--	X	--	--
2,4,6-Trichlorophenol	--	--	--	--
2-Methylphenol	--	--	--	--
4-Methylphenol	--	--	--	--
Benzoic acid	--	--	--	--
2,4,5-Trichlorophenol	--	--	--	--
PESTICIDES/PCBs				
alpha-BHC	--	--	--	--
beta-BHC	--	--	--	--
gamma-BHC	--	--	--	--
delta-BHC	--	--	--	--
Aldrin	--	--	--	--
Chlordane	--	--	--	--
4,4'-DDD	--	--	--	--
4,4'-DDE	--	X	--	--
4,4'-DDT	--	--	--	--
Dieldrin	--	--	--	--

TABLE A2-1 (Continued)

SUMMARY OF SITE CONSTITUENTS ANALYZED^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Analytical Parameters	Site Soils	Site Groundwater ^b	Site Surface Water	Site Sediment
Endosulfan I	--	--	--	--
Endosulfan II	--	--	--	--
Endosulfan sulfate	--	--	--	--
Endrin	--	--	--	--
Endrin aldehyde	--	--	--	--
Heptachlor	--	--	--	--
Heptachlor epoxide	--	--	--	--
Methoxychlor	--	--	--	--
Toxaphene	--	--	--	--
PCB-1016	--	--	--	--
PCB-1221	--	--	--	--
PCB-1232	--	--	--	--
PCB-1242	--	--	--	--
PCB-1248	--	--	--	--
PCB-1254	--	--	--	--
PCB-1260	--	--	--	--
INORGANICS				
Aluminum	X	NA ^f	X	X
Antimony	X	NA	--	X
Arsenic	X	X	X	X
Barium	X	NA	X	X
Beryllium ^g	X	NA	--	X
Cadmium ^g	--	NA	--	X
Calcium ^g	X	X	X	X
Chromium (total)	X	X	X	X
Chromium (hexavalent)	NA	X ^b	X	NA
Cobalt ^g	X	NA	--	X
Copper	X	NA	X	X
Iron	X	X	X	X
Lead	X	X	X	X
Magnesium ^g	X	X	X	X
Manganese	X	NA	X	X
Mercury ^g	X ^e	NA	--	X
Nickel	X	X	X	X
Potassium ^g	X	X	X	X
Selenium ^g	--	NA	--	--
Silver ^g	--	NA	--	X
Sodium ^g	X	X	X	X
Thallium ^g	X ^e	NA	--	--

TABLE A2-1 (Continued)
SUMMARY OF SITE CONSTITUENTS ANALYZED^a
RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Analytical Parameters	Site Soils	Site Groundwater ^b	Site Surface Water	Site Sediment
Vanadium ^g	X	NA	--	X
Zinc	X	X	X	X
Cyanide	X	NA	--	--

^aAll samples were not analyzed for the complete list of analytical parameters (see Section 3.0 of the RI report). If a detected constituent was completely eliminated from a medium on the basis of the method blank evaluation conducted during the RI (see Section 5.0 of the RI report), then it is not identified as a detected constituent on this table. Otherwise all detected constituents (including background) are reflected on this table.

^bOnly samples analyzed for soluble inorganics in groundwater are reflected in this summary table with the exception of hexavalent chromium. Hexavalent chromium was measured only in the unfiltered groundwater samples.

^cAn "X" indicates the constituent was detected in the database noted (see Section 5.0 of the RI report).

^dDashes (--) indicate the constituent was analyzed for (in at least one sample from within the database) but was not detected (see Section 5.0 of the RI report).

^eConstituent was detected only at background soil locations.

^fNA indicates the constituent was not analyzed for in any samples from within the database.

^gConstituent was not retained of interest (in all site media) as a result of the RI data evaluation.

Data summaries were prepared for each of the Randall Textron plant media which had been sampled and analyzed for constituents of interest. These data summaries are different from those presented within Section 5.0 of the RI report in that the media have been further subdivided (e.g. soils have been subdivided into interim action area soils, soils under pavement, and remainder of site soils, as is discussed in detail in Section A2.2), and the arithmetic mean of detected constituents, detection limits, and relevant background concentrations are presented. Data are presented only for those constituents retained of interest upon completion of the RI data evaluation for blanks and background comparisons (see Section 5.0 of the RI report). Samples associated with each database are identified in Attachment I; actual data are presented in Appendix D of the RI report. Duplicate samples were retained within the database and treated as individual sample points.

A2.1 EVALUATION OF DATA

Each data summary created for the media of interest at the site includes the analytical method detection limits, frequency of detection, arithmetic mean of detected constituents, and range of detected constituents (all of which exclude background data); summaries of background concentrations are presented where appropriate. Some qualified data are retained for use in the baseline risk assessment, therefore, it is necessary to discuss the use of data qualifiers.

A2.1.1 Data Qualifiers

Data qualifiers may be assigned to certain data either during sample analysis or data validation. J-, B-, D-, and E-qualifiers were assigned to relevant data by the ECKENFELDER INC. laboratory. In order to determine calculated parameters such as the arithmetic mean of all samples, it was necessary to assign values to data which had qualifiers. Values were assigned to J-, B-, D-, and E-qualified data in accordance with *Risk Assessment Guidance for Superfund, Volume I--Human Health Evaluation Manual, Part A* (RAGS Part A; USEPA, 1989a) and USEPA's *Guidance for Data Useability in Risk Assessment* (USEPA, 1992a). An additional X-qualifier was assigned to some data points by the ECKENFELDER INC. RI/FS team as is discussed below (and in Section 5.0 of the RI report). Values were assigned to U- and UD-qualified data based on verbal guidance received from USEPA Region IV

(Personal Communication, 1991). Data qualifiers used and values assigned are described below.

U-qualified data: The presence of a "U" indicated that the constituent was analyzed for but not detected; the sample quantitation limit (SQL) was reported with U-qualified data. As noted in RAGS Part A, in determining the concentrations most representative of potential exposures, the positively detected results should be considered together with nondetect results. Nondetect results should not be omitted from the baseline risk assessment (USEPA, 1989a). Therefore, values must be assumed to represent nondetect data. Per the USEPA Region IV (Personal Communication, 1991), each of the SQLs reported for U-qualified data was multiplied by 0.5 and retained in the database for use in the calculation of constituent-specific statistics. For example, for groundwater sample number 5115 from MW-5, the analytical result for methylene chloride was 2U $\mu\text{g/L}$. This SQL was multiplied by 0.5, and the result (1.0 $\mu\text{g/L}$) was retained in the database and used to represent that sample point. Constituents that were not detected in any sample for a given medium were not considered constituents of interest, and therefore the 0.5 multiplier was not used. However, in many cases, the SQL reported with U-qualified data was extremely high when compared with other detected data for that medium. If the use of one-half the SQL to represent nondetect data resulted in unusually high values when compared with detected concentrations, their use in a database could bias high the resulting exposure concentrations that will be used to evaluate risk (exposure concentrations are discussed in Section A3.0). Therefore, an effort was made by the ECKENFELDER INC. RI/FS team to evaluate unusually high SQLs in order to obtain values which more accurately represent site media concentrations. This method is described in the following discussion of the UD-qualifier.

UD-qualified data: The presence of "UD" indicated that the constituent was analyzed for but not detected and the sample was diluted for re-analysis because one or more of the constituent concentrations exceeded the highest concentration range for the standard curve. In most cases, per USEPA Region IV (Personal Communication, 1991), each of the SQLs reported for UD-qualified data was multiplied by 0.5 and retained in the database. However, in many cases, the SQL reported with UD-qualified data, as with the U-qualified data, was extremely high.

In order to evaluate data with unusually high SQLs, U- and UD-qualified data were first multiplied by 0.5 and then compared to the maximum concentration detected for a specific constituent in a given environmental medium. If the U- or UD-qualified data point (multiplied by 0.5) exceeded the maximum value ever detected for that constituent and medium, (i.e., the maximum value not qualified with a "U" or "UD"), the data point was completely eliminated from the database and not used in the determination of constituent-specific statistics. For instance, for groundwater sample number 9244 from MW-2, the analytical result for methylene chloride was 10,000 UD $\mu\text{g/L}$. This SQL was multiplied by 0.5 (resulting in 5,000 $\mu\text{g/L}$) and compared to the maximum detected concentration for methylene chloride in the groundwater database (1,700 $\mu\text{g/L}$). Because the SQL multiplied by 0.5 (5,000 $\mu\text{g/L}$) was greater than the maximum detected concentration, (1,700 $\mu\text{g/L}$), this sample point for methylene chloride was not further evaluated and the total number of groundwater samples analyzed for this constituent was decreased by one. If the SQL multiplied by 0.5 had been less than the maximum detected concentration, the sample point would have been retained in the database.

X-qualified data: Some data were qualified with an "X" which denotes the result was associated with a laboratory contaminant. These data were designated by the ECKENFELDER INC. RI/FS team as a result of a comparison of sample results with analytical results for field blanks, equipment blanks, and laboratory blanks. Consistent with RAGS Part A (USEPA, 1989a), if a sample contained concentrations of "common" laboratory contaminants (e.g., acetone, 2-butanone, methylene chloride, toluene, and phthalate esters) which were less than 10 times the maximum amount detected in any blank, it was concluded that the constituent was not truly detected in that particular sample because of laboratory contamination. Likewise, if a sample contained concentrations of laboratory constituents that were not considered to be common laboratory contaminants but were present in concentrations less than five times the maximum amount detected in any blank, it was concluded that the constituents were not truly detected in that particular sample. Sample data which met this criteria were qualified with an "X" by the RI/FS team and recorded in the database (see Appendix D of the RI report). Per RAGS Part A (USEPA, 1989a), these data were treated in the same manner as nondetect (i.e., U- or UD-qualified) data when calculating constituent-specific statistics (i.e., the analytical result was multiplied by 0.5 and the value was retained in the database). The evaluation of

data to determine the need for the X-qualifier was presented in detail within Section 5.0 of the RI report, by medium.

J-qualified data: The presence of a "J" indicated that the mass spectral data passed the identification criteria showing that the constituent was present, but the calculated result was less than the practical quantitation limit (PQL), the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. Therefore, the analytical result is considered to be estimated. Unless the data points were further qualified by an "X," the values reported for J-qualified data were left unchanged and retained in the database and used in the calculation of chemical-specific statistics.

B-qualified data: The presence of a "B" indicated that the constituent was also detected in the method blank. Unless the data point was further qualified by an "X," the value reported was left unchanged and retained in the database for use in the calculation of chemical-specific statistics.

D-qualified data: The presence of a "D" indicated that the sample was diluted and re-analyzed because one or more of the constituent concentrations exceeded the highest concentration range for the standard curve. Unless the data points were further qualified by an "X," the values reported for D-qualified data were left unchanged and retained in the database for use in the calculation of chemical-specific statistics.

E-qualified data: The concentration for any constituent that exceeded the highest concentration level on the standard curve for that constituent was flagged with an "E." Unless data points were further qualified by an "X," E-qualified data were left unchanged and retained in the database for use in the calculation of chemical-specific statistics.

A2.1.2 Data Summaries

The **frequency of detection** was calculated for each constituent in each medium. The frequency of detection was defined as the ratio of the total number of samples with detectable concentrations divided by the total number of samples analyzed for a specific medium. Unqualified data, and J-, B-, D- and E-qualified data were

included in the total number of samples with detectable concentrations; U-, UD- and X-qualified data were not included. All sample points were included in the total number of samples analyzed (except for U- and UD-qualified data points which had been eliminated from the database because of unusually high SQLs, as described above). Background data were not included in the calculation of frequencies of detection. Any constituent with a frequency of detection greater than zero, taking into account all data qualifiers and the RI data evaluation (i.e., the evaluation for blanks and background comparisons (see Section 5.0 of the RI report)), was retained within the medium of interest for further evaluation in the baseline risk assessment.

Per RAGS Part A, in the determination of the **arithmetic mean** of detected constituents all unqualified data, and J-, B-, D- and E-qualified data were utilized in the calculation of the mean (USEPA, 1989a). U-, UD- and X-qualified data were not included. Background data were not included in the calculation of the arithmetic means for the constituents of interest. Relevant background data are presented separately. All calculated values for organic constituents have been rounded to two significant digits, and calculated values for the inorganic constituents of interest have been rounded to three significant digits based upon the number of significant digits reported in the actual data (see Appendix D of the RI report).

The **range** of detected concentrations presented in the data summary tables incorporates those data which were above method detection limits (i.e., were detected) and data which have not been eliminated due to laboratory, transportation, or field procedures (i.e., X-qualified data).

A2.1.3 Data Evaluation Techniques

Data evaluation techniques utilized in the RI report included: the evaluation of laboratory, transportation, or field contamination through a comparison of measured concentrations to associated laboratory blanks; the evaluation of inorganic constituents as occurring within measured background ranges, or within occurring natural ranges, and the evaluation of inorganic constituents as major common ions (see Section 5.0 of the RI report).

In addition to incorporating these evaluation techniques, the risk assessment will focus the evaluation on the primary constituents of interest by evaluating data

presented within each medium of interest with respect to frequency of detection. As noted in RAGS Part A, constituents that are infrequently detected may not be related to site operations or disposal practices (USEPA, 1989a). Therefore, any constituent that was detected in five percent or less of the samples within a specific database will be eliminated from further interest in the risk assessment. In this manner, the risk assessment will be focused on the constituents that present the greatest interest at the site. Constituents discounted on the basis of this frequency of detection criterion are discussed within the text in the following sections. In addition, each media summary table specifies the basis on which a constituent was discounted.

A2.2 SOILS

Based upon the evaluation of the fate and transport of constituents of interest at the site (Section 7.0 of the RI report) three primary sources of constituents of interest in soils were identified: the interim action area or on-site landfill, the former solvent storage areas (toluene and trichloroethene (TCE)), and the chromium reduction process components (see further discussions in Section A3.0). The soil samples from the site were, for the most part, collected from three distinct areas: 1) the on-site landfill; 2) the former solvent storage areas; and 3) background locations. The remaining soil samples not associated with these three areas were collected from a number of different locations of the site (see Figure 3-3 of the RI report). Therefore, for the purposes of the baseline risk assessment, the soils database was divided into four separate databases: the interim action area soils, soils under pavement (which represent both the former toluene and former trichloroethene storage areas), remainder of site soils (which are not known to be specifically associated with any known sources), and background soils. This presentation of soil data is different from that in Section 5.0 of the RI report, but it nevertheless incorporates all of the soils data. This presentation of soils for the baseline risk assessment allows for the direct evaluation of known source areas, resulting soil concentrations, and potential exposures.

As will be discussed further in Section A3.7, potential exposures to soil may be expected to occur to surficial soils (i.e., soils from 0 to 0.5 feet) and shallow soils (i.e., soils from 0 to 8.0 feet). It was not considered likely that any human populations which may come in contact with soils would encounter soil at depths of greater than

8 feet, regardless of the types of activities performed. It should be noted that two samples from depths greater than 8 feet were collected, SB-11, 8 to 10 feet, and SB-12, 10.5 to 12 feet, both from the interim action area. These samples are not included in the evaluation of interim action area soils presented within the baseline risk assessment.

A list of the samples associated with each database is presented in Attachment I. An overall summary of the constituents detected in these soil areas is presented in Table A2-2. The actual data are presented in Appendix D of the RI report. The data summaries for these soil groups are presented in the following paragraphs.

Interim Action Soils. Table A2-3 presents the data summary for the interim action soils. Table A2-3 indicates that 15 VOCs were detected in interim action soils. The most frequently detected VOCs included: trichloroethene (50 of 63 samples), acetone (42 of 63 samples), 1,2-dichloroethene (total) (32 of 63 samples), xylene (total) (22 of 63 samples), and toluene (19 of 63 samples). Four volatile organics, chloromethane, 2-hexanone, methylene chloride, and 4-methyl-2-pentanone were present in less than five percent of the samples; therefore, these four constituents will not be retained as constituents of interest in the interim action soils.

Two semivolatiles were detected in interim action soils, 2-methylnaphthalene (two of three samples) and naphthalene (two of three samples). No pesticides or PCBs were detected in the interim action soils.

Of the inorganic constituents for which interim action soils were analyzed, four metals, chromium, lead, nickel, and zinc, have been retained as constituents of interest. The remaining metals (except for arsenic) were eliminated during the RI on the basis of comparison to background levels and to the range of typical concentrations in soils (see Section 5.2.1.2 of the RI report). Since the soils were separated into four databases for the baseline risk assessment, levels of inorganic constituents retained of interest in the RI were re-evaluated in comparison to calculated upper tolerance limits (UTLs) which are based on background levels of inorganics in soils. This evaluation indicated that arsenic in the interim action soils (maximum detection of 9.7 mg/kg) was well below the UTL for arsenic (17.23 mg/kg) (see Section 5.2.1.2 of the RI report). Therefore, arsenic will not be retained as a

TABLE A2-2

SUMMARY OF CONSTITUENTS IN SOILS^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Interim Action Area	Soils Under Pavement	Remainder of Site	Background
VOLATILE ORGANICS				
Acetone	X ^b	X	X	X
Benzene	--	X	-- ^c	--
2-Butanone	X	X	--	--
Chloroform	X	--	--	--
Chloromethane	X	--	--	--
1,2-Dichloroethene (total)	X	X	--	--
Ethyl benzene	X	X	--	--
2-Hexanone	X	--	--	--
4-Methyl-2-Pentanone	X	--	--	--
Methylene chloride	X	X	X	--
Styrene	--	--	--	X
1,1,2,2-Tetrachloroethane	X	--	--	--
Tetrachloroethene	X	X	--	--
Toluene	X	X	--	--
1,1,1-Trichloroethane	--	X	--	--
1,1,2-Trichloroethane	X	--	--	--
Trichloroethene	X	X	X	--
Vinyl chloride	--	X	--	--
Xylene (total)	X	X	--	--
SEMIVOLATILE ORGANICS				
2-Chlorophenol	--	NA ^d	NA	X
Diethyl phthalate	--	NA	NA	X
2-Methylnaphthalene	X	NA	NA	--
Naphthalene	X	NA	NA	--
PESTICIDES/PCBs				
None Detected				
INORGANICS				
Aluminum	E ^e	NA	NA	E
Antimony	E	NA	NA	--
Arsenic	X	X	X	X
Barium	E	NA	NA	E
Beryllium	E	NA	NA	E

TABLE A2-2 (Continued)
SUMMARY OF CONSTITUENTS IN SOILS^a
RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Interim Action Area	Soils Under Pavement	Remainder of Site	Background
Calcium	E	NA	NA	E
Chromium (total)	X	X	X	X
Cobalt	E	NA	NA	E
Copper	E	NA	NA	E
Cyanide	X	NA	NA	--
Iron	E	NA	NA	E
Lead	X	X	X	X
Magnesium	E	NA	NA	E
Manganese	E	NA	NA	E
Mercury	--	NA	NA	E
Nickel	X	X	X	X
Potassium	E	NA	NA	E
Sodium	E	NA	NA	E
Thallium	--	NA	NA	E
Vanadium	E	NA	NA	E
Zinc	X	X	X	X

^aAll samples were not analyzed for all classes of analytical parameters (see Section 3.0 of the RI report). If a constituent was completely eliminated from a database on the basis of the blank evaluations conducted during the RI (see Section 5.0 of the RI report), then it is not identified as a detected constituent on this table (i.e., not indicated with an "X"). Otherwise, all detected constituents are reflected on this table.

^bAn "X" indicates the constituent was detected in the soil database noted (see Section 5.2 of the RI report).

^cDashes (--) indicate the constituent was analyzed for (in at least one sample from within the database) but was not detected (see Section 5.2 of the RI report).

^dNA indicates the constituent was not analyzed for in any samples from within the database (see Section 5.2 of the RI report).

^eAn "E" indicates the constituent was detected but eliminated upon completion of the RI data evaluation of background (see Section 5.0 of the RI report).

TABLE A2-3

**DATA SUMMARY OF CONSTITUENTS IN ON-SITE SOIL
INTERIM ACTION AREA (0 TO 8 FEET)^a**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Constituent	Method Detection Limit ^b	Interim Action Area			Background		Retained? (Y/N)	Reason for Exclusion/Remarks
		Frequency of Detection ^c (%)	Arithmetic Mean of Detected Constituents ^d	Range of Detected Values (Minimum- Maximum)	Detected Values or UTL ^e			
VOLATILE ORGANICS (µg/kg)								
Acetone	5.0/630	42/63 (66.7)	3,800	35 - 20,000	92 - 55,000	Y		
2-Butanone	10/1200	3/55 (5.5)	220	32 - 370	ND ^f	Y		
Chloroform	1.0/130	3/55 (5.5)	7.2	3.3 - 9.9	ND	Y		
Chloromethane	2.0/250	1/55 (1.8)	95	95	ND	N	5% frequency of detection	
1,2-Dichloroethene (total)	1.0/130	32/63 (50.8)	2,300	3.4 - 64,000	ND	Y		
Ethyl benzene	1.0/130	14/63 (22.2)	4,800	6.3 - 17,000	ND	Y		
2-Hexanone	2.0/250	1/55 (1.8)	19	19	ND	N	5% frequency of detection	
Methylene chloride	2.0/250	1/63 (1.6)	330	330	ND	N	5% frequency of detection	
4-Methyl-2-pentanone	2.0/250	2/55 (3.6)	15	5.2 - 25	ND	N	5% frequency of detection	
1,1,2,2-Tetrachloroethane	1.0/130	9/63 (14.3)	130	3.4 - 870	ND	Y	5% frequency of detection	
Tetrachloroethene	1.0/130	11/63 (17.5)	760	2.0 - 5,900	ND	Y		
Toluene	1.0/130	19/63 (30.2)	5200	3.1 - 84,000	ND	Y		
1,1,2-Trichloroethane	1.0/130	4/63 (6.3)	870	30 - 2,300	ND	Y		
Trichloroethene	1.0/130	50/63 (79.4)	160,000	4.2 - 5,400,000	ND	Y		
Xylene (total)	2.0/1.0/250	22/63 (34.9)	15,000	3.2 - 93,000	ND	Y		

PESTICIDES (mg/kg)

None Detected

TABLE A2-3 (Continued)

**DATA SUMMARY OF CONSTITUENTS IN ON-SITE SOIL
INTERIM ACTION AREA (0 TO 8 FEET)^a**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Constituent	Method Detection Limit ^b	Interim Action Area			Background Range of Detected Values or UTL ^e	Retained? (Y/N)	Reason for Exclusion/Remarks
		Frequency of Detection ^c (%)	Arithmetic Mean of Detected Constituents ^d	Range of Detected Values (Minimum- Maximum)			
INORGANICS (mg/kg)							
Arsenic	0.25/0.50/0.25	61/63 (96.8)	4.65	0.58 - 9.7	17.23g	N	Maximum measured less than UTL
Chromium (total)	0.10/0.20/0.10	63/63 (100.0)	1,140	11 - 11,700	65.63g	Y	
Cyanide	1.0	1/3 (33.3)	1.3	1.3	ND	Y	
Lead	5.0/2.0/1.0	62/63 (98.4)	19.5	4.6 - 110	39.43g	Y	
Nickel	0.35/0.70/0.35	63/63 (100.0)	434	8.1 - 3,610	38.04g	Y	
Zinc	0.35/0.70/0.35	63/63 (100.0)	53.3	12 - 146	111.19g	Y	

^aData are presented only for those constituents retained of interest upon completion of the RI data evaluation for blanks and background comparisons (see Section 5.0 of the RI report). Data are presented in Appendix D of the RI report.

^bDetection limits varied. For volatile organics the first value presents the standard low level analysis detection limits; the second value presents the standard medium level analysis detection limits. In the May 1993 samples the low level detection limit for xylenes (total) was 1.0 µg/kg. Semivolatiles were only analyzed through the low level method. For inorganics, the first value represents the August 1991 samples, the second value represents samples from November 1991 through December 1992, and the third value represents samples from May 1993. Samples were not analyzed for cyanide after the end of 1991.

^cTotal number of samples may vary. Nondetect data is represented by one-half the detection limit. However, if one-half the detection limit exceeded the maximum detection, then the constituent-specific sample result was discounted and the total number of samples for that constituent was decreased by one.

^dArithmetic means were determined using normal statistics; means are rounded to two significant digits for organics and three significant digits for inorganics.

^eUTLs are the upper tolerance limits for selected inorganics which are based on measured values for background samples (see Table 5-3 of the RI report).

^fND indicates the constituent was not detected in any samples from the database of interest.

^gValue is the UTL for the referenced constituent (see Table 5-3 of the RI report).

constituent of interest in interim action soils. The most frequently detected metals that were retained of interest included chromium, nickel, and zinc which were each detected in 63 of 63 samples. In addition, cyanide, which was detected in one of three interim action soil samples, was also retained as a constituent of interest.

Soils Under Pavement. Table A2-4 presents the data summary for soils under pavement. Twelve VOCs were detected in soils under pavement. The most frequently detected VOCs were acetone (42 of 62 samples) and toluene (21 of 62 samples). Six volatile organics, benzene, 2-butanone, ethyl benzene, tetrachloroethene, 1,1,1-trichloroethane, and vinyl chloride, were present in less than 5 percent of the samples; therefore, these six constituents will not be retained as constituents of interest in the soils under pavement.

Soils under pavement were not analyzed for semivolatiles or pesticides/PCBs. These soils were analyzed for the routine soil parameter list for inorganics (see Table 3-3 and Section 5.2.1.2 of the RI report) which included arsenic, chromium, lead, nickel, and zinc. Four of these metals, arsenic, chromium, lead, and zinc, were retained of interest in soils under pavement, all of which were detected in 62 of 62 samples. The re-evaluation of inorganic constituents retained of interest in the RI, after the soils were separated into the four databases, indicated that nickel in the soils under pavement (maximum detection of 35.6 mg/kg) was below the UTL of 38.04 for nickel (see Section 5.2.1.2 of the RI report). Therefore, nickel will not be retained as a constituent of interest in soils under pavement.

Remainder of Site Soils. Table A2-5 presents the data summary for the remainder of site soils. Three VOCs were detected in the remainder of site soils. All three volatile organics were detected frequently; acetone was detected in 11 of 20 samples, methylene chloride was detected in 11 of 20 samples, and trichloroethene (TCE) was detected in 10 of 20 samples. The remainder of site soils were not analyzed for semivolatiles or pesticides/PCBs.

The remainder of site soils were analyzed for the routine soil parameter list (see Table 3-3 and Section 5.2.1.2 of the RI report) which included arsenic, chromium, lead, nickel, and zinc. Three of these metals, chromium, nickel, and zinc, were retained of interest in the remainder of site soils. Chromium and zinc were each detected in 20 of 20 samples. The re-evaluation of inorganic constituents retained of

TABLE A2-4

**DATA SUMMARY OF CONSTITUENTS IN ON-SITE SOIL
UNDER PAVEMENT (0 TO 8 FEET)^a**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Constituent	Method Detection Limit ^b	Soil Under Pavement			Background Range of Detected Values or UTL ^e	Retained? (Y/N)	Reason for Exclusion/Remarks
		Frequency of Detection ^c (%)	Arithmetic Mean of Detected Constituents ^d	Range of Detected Values (Minimum- Maximum)			
VOLATILE ORGANICS (µg/kg)							
Acetone	5.0/630	42/62 (67.7)	1,700	25 - 36,000	92 - 55,000	Y	5% frequency of detection
Benzene	1.0/130	1/55 (1.8)	3.0	3.0	ND ^f	N	5% frequency of detection
2-Butanone	10/1,200	1/55 (1.8)	19	19	ND	N	5% frequency of detection
1,2-Dichloroethene (total)	1.0/130	17/62 (27.4)	4,700	3.7 - 54,000	ND	Y	5% frequency of detection
Ethyl benzene	1.0/130	2/59 (3.4)	210	23 - 390	ND	N	5% frequency of detection
Methylene chloride	2.0/250	13/62 (21.0)	410	3.5 - 5,100	ND	Y	5% frequency of detection
Tetrachloroethene	1.0/130	3/62 (4.8)	7,500	5,000 - 11,000	ND	N	5% frequency of detection
Toluene	1.0/130	21/62 (33.9)	3,700	4.4 - 56,000	ND	Y	5% frequency of detection
1,1,1-Trichloroethane	1.0/130	1/62 (1.6)	5,600	5,600	ND	N	5% frequency of detection
Trichloroethene	1.0/130	14/62 (22.6)	360,000	2.4 - 1,800,000	ND	Y	5% frequency of detection
Vinyl chloride	2.0/250	2/62 (3.2)	6,500	7.2 - 13,000	ND	N	5% frequency of detection
Xylene (total)	2.0/1.0/250	5/59 (8.5)	150	5.1 - 700	ND	Y	5% frequency of detection

SEMIVOLATILE ORGANICS (mg/kg)

Not Analyzed For

PESTICIDES (mg/kg)

Not Analyzed For

TABLE A2-4 (Continued)

**DATA SUMMARY OF CONSTITUENTS IN ON-SITE SOIL
UNDER PAVEMENT (0 TO 8 FEET)^a**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Constituent	Method Detection Limits ^b	Soil Under Pavement			Background Range of Detected Values or UTLs ^e	Retained? (Y/N)	Reason for Exclusion/Remarks
		Frequency of Detection ^c (%)	Arithmetic Mean of Detected Constituents ^d	Range of Detected Values (Minimum- Maximum)			
INORGANICS (mg/kg)							
Arsenic	0.25/0.50/0.25	62/62 (100.0)	6.15	0.41 - 24.7	17.23g	Y	
Chromium (total)	0.10/0.20/0.10	62/62 (100.0)	15.8	2.4 - 104	65.63g	Y	
Lead	5.0/2.0/1.0	62/62 (100.0)	15.7	4.8 - 51	39.43g	Y	
Nickel	0.35/0.70/0.35	62/62 (100.0)	10.9	0.45 - 35.6	38.04g	N	Maximum measured less than UTL
Zinc	0.35/0.70/0.35	62/62 (100.0)	39.6	4.4 - 141	111.19g	Y	

^aData are presented only for those constituents retained of interest upon completion of the RI data evaluation for blanks and background comparisons (see Section 5.0 of the RI report). Data are presented in Appendix D of the RI report.

^bDetection limits varied. For volatile organics, the first value presents the standard low level analysis detection limits; the second value presents the standard medium level analysis detection limits. In the May 1993 samples, the low level detection limit for xylene (total) was 1.0 µg/kg. For inorganics, the first value represents the August 1991 samples, the second value represents samples from November 1991 through December 1992, and the third value represents samples from May 1993.

^cTotal number of samples may vary. Nondetect data is represented by one-half the detection limit. However, if one-half the detection limit exceeded the maximum detection, then the constituent-specific sample result was discounted and the total number of samples for that constituent was decreased by one.

^dArithmetic means were determined using normal statistics; means are rounded to two significant digits for organics and three significant digits for inorganics.

^eUTLs are the upper tolerance limits for selected inorganics which are based on measured values of background samples (see Table 5-3 of the RI report).

^fND indicates the constituent was not detected in any samples from the database of interest.

^gValue is the UTL for the referenced constituent (see Table 5-3 of the RI report).

TABLE A2-5

**DATA SUMMARY OF CONSTITUENTS IN ON-SITE SOIL
REMAINDER OF SITE (0 TO 8 FEET)^a**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Constituent Detected	Method Detection Limit ^b	Remainder of Site Soils			Background Range of Detected Values or UTL ^e	Retained? (Y/N)	Reason for Exclusion/Remarks
		Frequency of Detection ^c (%)	Arithmetic Mean of Detected Constituents ^d	Range of Detected Values (Minimum- Maximum)			
VOLATILE ORGANICS (µg/kg)							
Acetone	5.0/630	11/20 (55.0)	12,000	38 - 74,000	92 - 55,000	Y	
Methylene chloride	2.0/250	11/20 (55.0)	11	3.7 - 15	ND ^f	Y	
Trichloroethene	1.0/130	10/20 (50.0)	12	5.1 - 22	ND	Y	
SEMIVOLATILE ORGANICS (mg/kg)							
Not Analyzed For							
PESTICIDES (mg/kg)							
Not Analyzed For							
INORGANICS (mg/kg)							
Arsenic	0.25/0.50/0.25	20/20 (100.0)	4.77	0.57 - 9.8	17.23g	N	Maximum measured less than UTL
Chromium (total)	0.10/0.20/0.10	20/20 (100.0)	25.1	1.6 - 193	65.63g	Y	
Lead	5.0/2.0/1.0	20/20 (100.0)	14.0	4.6 - 25	39.43g	N	Maximum measured less than UTL
Nickel	0.35/0.70/0.35	19/20 (95.0)	18.4	6.0 - 94	38.04g	Y	
Zinc	0.35/0.70/0.35	20/20 (100.0)	56.1	2.8 - 218	111.19g	Y	

^aData are presented only for those constituents retained of interest upon completion of the RI data evaluation for blanks and background comparisons (see Section 5.0 of the RI report). Data are presented in Appendix D of the RI report.

^bDetection limits varied. For volatile organics, the first value presents the standard low level analysis detection limits; the second value presents the standard medium level analysis detection limits. For inorganics, the first value represents the August 1991 samples, the second value represents samples from November 1991 through December 1992, and the third value represents samples from May 1993.

^cTotal number of samples may vary. Nondetect data is represented by one-half the detection limit. However, if one-half the detection limit exceeded the maximum detection, then the constituent-specific sample result was discounted and the total number of samples for that constituent was decreased by one.

^dArithmetic means were determined using normal statistics; means are rounded to two significant digits for organics and three significant digits for inorganics.

^eUTLs are the upper tolerance limits for selected inorganics which are based on background samples (see Table 5-3 of the RI report).

^fND indicates the constituent was not detected in any samples from the database of interest.

^gValue is the UTL for the referenced constituent (see Table 5-3 of the RI report).

interest in the RI, after the soils were separated into the four databases, indicated that arsenic and lead in the remainder of site soils (maximum detections of 9.8 and 25 mg/kg, respectively) were below their respective UTLs of 17.23 mg/kg for arsenic and 39.43 mg/kg for lead (see Section 5.2.1.2 of the RI report). Therefore, arsenic and lead will not be retained as constituents of interest in the remainder of site soils.

Background Soils. Background soil data have been summarized on the preceding soil tables. Two VOCs were detected in background soils, acetone (four of six samples) and styrene (one of six samples). Acetone was detected in a range of 92 to 55,000 $\mu\text{g/kg}$ in background soils. Styrene, present at a very low concentration of 4.3 $\mu\text{g/kg}$, was not detected in any other soils present at the site. Two semivolatiles were detected in one sample from background soils, 2-chlorophenol and diethyl phthalate. Both of these compounds were detected at very low concentrations of 0.02 and 0.01 mg/kg respectively, and were not detected in any other site soils. No pesticides or PCBs were detected in background soils. Of the five metals that were retained of interest in site soils, i.e., arsenic, chromium, lead, nickel, and zinc, all were detected in 19 of 19 background soil samples. The background concentrations of these constituents formed the basis of the UTLs which were presented in the preceding tables. A list of samples associated with background soils is presented in Attachment I; the actual data are presented in Appendix D of the RI report.

A2.3 SITE GROUNDWATER

Based upon the evaluation of groundwater presented in Section 5.4 of the RI report, there are three distinct water-bearing units from which site groundwater samples were obtained: 1) the uppermost aquifer; 2) the lower aquifer; and 3) the deeper water-bearing units below the lower aquifer. The uppermost aquifer is separated from the lower aquifer by the intermediate confining unit. The lower aquifer is in turn separated from the deeper water-bearing units by a second confining unit. Background locations along with the majority of the site groundwater samples were obtained from the uppermost aquifer. Therefore, site groundwater has been divided into four databases. These include the groundwater from the uppermost aquifer, groundwater from background locations in the uppermost aquifer, groundwater from MW-9 (which is located in the lower aquifer), and groundwater from the plant wells (which are in underlying water-bearing units below the lower aquifer). This

presentation of groundwater is slightly different than that presented within Section 5.4 of the RI report, but it nevertheless incorporates all groundwater data.

A list of samples which comprise each separate database is presented in Attachment I; the actual data are presented in Appendix D of the RI report. Sample locations are shown on Figure 3-3 of the RI report. An overall summary of the constituents detected in these four databases is presented in Table A2-6. The data summaries are discussed in the following sections.

Site Groundwater from the Uppermost Aquifer. Table A2-7 presents the data summary for the site groundwater from the uppermost aquifer. Table A2-7 indicates that 21 VOCs were detected in groundwater from the uppermost aquifer. The most frequently detected VOCs were TCE (52 of 55 samples) and 1,2-dichloroethene (total) (51 of 55 samples). Six volatile organics, chlorobenzene, chloroform, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,1-dichloroethane, and methylene chloride, were present in less than five percent of the samples from the uppermost aquifer; therefore, these six volatiles will not be retained of interest in the site groundwater.

Seven semivolatiles were detected in groundwater from the uppermost aquifer; the most frequently detected were phenanthrene (one of one sample) and bis(2-ethylhexyl)phthalate (seven of eight samples). Only one pesticide, 4,4'-DDE, (one of seven samples) was detected in the groundwater from the uppermost aquifer, and this was detected at a low concentration of 0.46 $\mu\text{g/L}$.

On-site groundwater was analyzed for unfiltered and soluble (filtered) inorganics. Evaluation of preliminary groundwater data during the RI indicated that the use of unfiltered concentrations was not representative because the samples were typically turbid with visible amounts of sediment, possibly due to the nature of the aquifer. It was believed that the unfiltered concentrations of inorganics were artificially elevated as a result of the presence of high levels of sediment. Therefore, to ensure a more representative determination of inorganic concentrations in groundwater, only soluble concentrations were evaluated in the RI (see Sections 3.1 and 5.4 of the RI report). As a result, only soluble concentrations of inorganics in groundwater will be evaluated in the baseline risk assessment.

TABLE A2-6

SUMMARY OF CONSTITUENTS IN GROUNDWATER^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Uppermost Aquifer	Background (Uppermost Aquifer)	MW-9 (Lower Aquifer)	Plant Wells (Deeper Water- Bearing Units)
VOLATILE ORGANICS				
Acetone	X ^b	-- ^c	X	X
Benzene	X	--	--	--
Chlorobenzene	X	--	--	--
Chloroform (total)	X	--	--	--
1,2-Dichlorobenzene	X	--	--	--
1,3-Dichlorobenzene	X	--	--	--
1,4-Dichlorobenzene	X	--	--	--
1,1-Dichloroethane	X	--	--	--
1,2-Dichloroethane	X	--	--	--
1,1-Dichloroethene	X	--	--	--
1,2-Dichloroethene (total)	X	--	--	--
Ethyl benzene	X	--	--	--
4-Methyl-2-Pentanone	X	--	--	--
Methylene chloride	X	--	--	--
Tetrachloroethene	X	--	--	--
Toluene	X	--	--	--
1,1,1-Trichloroethane	X	--	--	--
1,1,2-Trichloroethane	X	--	--	--
Trichloroethene	X	--	--	X
Vinyl chloride	X	--	--	--
Xylene (total)	X	--	--	--
SEMIVOLATILE ORGANICS				
bis(2-Ethylhexyl)phthalate	X	NA ^d	NA	NA
Fluorene	X	NA	NA	NA
2-Methylnaphthalene	X	NA	NA	NA
Naphthalene	X	NA	NA	NA
Phenanthrene	X	NA	NA	NA
Phenol	X	NA	NA	NA
1,2,4-Trichlorobenzene	X	NA	NA	NA
PESTICIDES/PCBs				
4,4'-DDE	X	NA	NA	NA

TABLE A2-6 (Continued)
SUMMARY OF CONSTITUENTS IN GROUNDWATER^a

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Constituent	Uppermost Aquifer	Background (Uppermost Aquifer)	MW-9 (Lower Aquifer)	Plant Wells (Deeper Water- Bearing Units)
INORGANICS (soluble)^e				
Arsenic	X	--	--	NA
Calcium	E ^f	E	E	E
Chromium (total)	X	--	--	NA
Chromium (hexavalent, unfiltered)	X	--	--	--
Chromium (total, unfiltered)	X	X	--	--
Iron	E	E	E	E
Lead	X	--	--	NA
Magnesium	E	E	E	E
Nickel	X	X	X	NA
Potassium	E	E	E	E
Sodium	E	E	E	E
Zinc	X	--	--	NA

^aAll samples were not analyzed for all classes of analytical parameters (see Section 3.0 of the RI report). If a constituent was completely eliminated from a database on the basis of the blank evaluations conducted during the RI (see Section 5.0 of the RI report), then it is not identified as a detected constituent on this table (i.e., not indicated with an "X"). Otherwise, all detected constituents are reflected on this table.

^bAn "X" indicates the constituent was detected in the groundwater database noted.

^cDashes (--) indicate the constituent was analyzed for (in at least one sample from within the database) but was not detected.

^dNA indicates the constituent was not analyzed for in any samples from within the database.

^eOnly groundwater samples analyzed for the soluble fraction of inorganic constituents are summarized in this table. Hexavalent VI chromium was not analyzed for in soluble groundwater data. However, hexavalent chromium was detected in unfiltered groundwater. The distribution of hexavalent chromium in unfiltered groundwater will be used to determine a percent distribution of hexavalent and trivalent III chromium for soluble groundwater concentrations (see Section A2.6). Therefore, chromium total (i.e., III and VI) and hexavalent chromium from unfiltered groundwater data are also reflected on this table.

^fAn "E" indicates the constituent was detected but eliminated upon completion of the RI data evaluation of background (see Section 5.0 of the RI report).

TABLE A2-7

**DATA SUMMARY OF CONSTITUENTS IN GROUNDWATER
UPPERMOST AQUIFER^a**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Constituent	Method Detection Limit	Uppermost Aquifer			Retained? (Y/N)	Reason for Exclusion/Remarks
		Frequency of Detection ^b (%)	Arithmetic Mean of Detected Constituents ^c	Range of		
				Detected Values (Minimum- Maximum)		
VOLATILE ORGANICS (µg/L)						
Acetone	5.0	5/45 (11.1)	220	4.2 - 970	Y	ND ^d
Benzene	1.0	5/53 (9.4)	130	0.5 - 630	Y	ND
Chlorobenzene	1.0	1/24 (4.2)	0.90	0.9	N	5% frequency of detection
Chloroform	1.0	1/45 (2.2)	140	140	N	5% frequency of detection
1,2-Dichlorobenzene	1.0	1/27 (3.7)	2.6	2.6	N	5% frequency of detection
1,3-Dichlorobenzene	1.0	1/24 (4.2)	1.2	1.2	N	5% frequency of detection
1,4-Dichlorobenzene	1.0	2/25 (8.0)	1.3	0.9 - 1.6	Y	5% frequency of detection
1,1-Dichloroethane	1.0	1/43 (2.3)	73	73	N	5% frequency of detection
1,2-Dichloroethane	1.0	4/31 (12.9)	7.1	1.9 - 12	Y	
1,1-Dichloroethene	2.0	6/53 (11.3)	500	6.7 - 2,500	Y	
1,2-Dichloroethene (total)	1.0	51/55 (92.7)	15,000	0.9 - 160,000	Y	
Ethyl benzene	1.0	6/55 (10.9)	610	6.9 - 3,300	Y	
Methylene chloride	2.0	2/53 (3.8)	950	190 - 1,700	N	5% frequency of detection
4-Methyl-2-pentanone	2.0	2/36 (5.6)	51	7.0 - 94	Y	
Tetrachloroethene	1.0	8/51 (15.7)	73	1.8 - 450	Y	
Toluene	1.0	10/55 (18.2)	82,000	0.7 - 660,000	Y	
1,1,1-Trichloroethane	1.0	2/33 (6.1)	12	4.6 - 19	Y	
1,1,2-Trichloroethane	1.0	5/45 (11.1)	39	3.2 - 160	Y	
Trichloroethene	1.0	52/55 (94.5)	51,000	2.3 - 690,000	Y	
Vinyl chloride	2.0	12/55 (21.8)	17,000	440 - 62,000	Y	
Xylene (total)	2.0/1.0 ^e	7/53 (13.2)	540	23 - 1,600	Y	

TABLE A2-7 (Continued)

**DATA SUMMARY OF CONSTITUENTS IN GROUNDWATER
UPPERMOST AQUIFER^a**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Constituent	Method Detection Limit	Uppermost Aquifer			Background	Retained? (Y/N)	Reason for Exclusion/Remarks
		Frequency of Detection ^b (%)	Arithmetic Mean of Detected Constituents ^c	Range of Detected Values (Minimum- Maximum)	Range of Detected Values		
SEMIVOLATILE ORGANICS (µg/L)							
bis(2-ethylhexyl)phthalate	2.0	7/8 (87.5)	2.5	0.7 - 7.1	NA ^f	Y	
Fluorene	2.0	1/8 (12.5)	1.0	1.0	NA	Y	
2-Methylnaphthalene	2.0	2/8 (25.0)	35	1.3 - 69	NA	Y	
Naphthalene	2.0	2/8 (25.0)	18	0.9 - 34	NA	Y	
Phenanthrene	2.0	1/1 (100.0)	0.7	0.7	NA	Y	
Phenol	2.0	2/8 (25.0)	4.5	1.2 - 7.7	NA	Y	
1,2,4-Trichlorobenzene	2.0	1/8 (12.5)	2.1	2.1	NA	Y	
PESTICIDES (µg/L)							
4,4'-DDE	0.10	1/7 (14.3)	0.46	0.46	NA	Y	
INORGANICS (soluble) (µg/L)							
Arsenic	5.0	5/27 (18.5)	24.3	5.7 - 54	ND	Y	Percent of hexavalent chromium in unfiltered samples will be used only to evaluate chromium (total, soluble) distribution (see Section A2.6)
Chromium (total)	2.0	14/33 (42.4)	5,180	3.1 - 54,800	ND	Y	
Chromium (total, unfiltered)	2.0	43/55 (78.2)	2,210	12 - 58,800	117 - 144	N	
Chromium (hexavalent, unfiltered)	25	8/55 (14.5)	8,710	30 - 51,000	ND	N	Percent distribution of hexavalent chromium in unfiltered samples will be used only to evaluate chromium (total, soluble) distribution (see Section A2.6)

TABLE A2-7 (Continued)

DATA SUMMARY OF CONSTITUENTS IN GROUNDWATER
UPPERMOST AQUIFER^a

RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Method Detection Limit	Uppermost Aquifer			Retained? (Y/N)	Reason for Exclusion/Remarks
		Frequency of Detection ^b (%)	Arithmetic Mean of Detected Constituents ^c	Range of Detected Values (Minimum- Maximum)		
Lead	3.0	1/27 (3.7)	7.9	7.9	N	5% frequency of detection
Nickel	7.0	13/27 (48.1)	11.5	8.1 - 18	Y	
Zinc	7.0/15.0 ^d	1/27 (3.7)	151	151	N	5% frequency of detection

^aData are presented only for those constituents retained of interest upon completion of the RI data evaluation for blanks and background comparisons (see Section 5.0 of the RI report). Data are presented in Appendix D of the RI report.

^bTotal number of samples may vary. Nondetect data is represented by one-half the detection limit. However, if one-half the detection limit exceeded the maximum detection, then the constituent-specific sample result was discounted and the total number of samples for that constituent was decreased by one.

^cArithmetic means were determined using normal statistics; means are rounded to two significant digits for organics and three significant digits for inorganics.

^dND indicates the constituent was not detected in any samples from the database of interest.

^eThe method detection limit for xylene was 1.0 µg/L for the 2/23/93, 2/24/93, and 6/15/93 sampling events. For all other sampling events the method detection limit for xylene was 2.0 µg/L.

^fNA indicates that the samples from the database of interest were not analyzed for the referenced constituent.

^gThe method detection limit for zinc was 7.0 µg/L for all sampling events except the 8/5/91 and 8/6/91 sampling events.

Of the inorganic constituents, five metals in the soluble fraction, arsenic, chromium (total), lead, nickel, and zinc, have been retained as constituents of interest. The most frequently detected metals that were retained of interest included chromium (total) (14 of 33 samples) and nickel (13 of 27 samples). Two inorganics, lead and zinc, were detected in less than five percent of the groundwater samples from the uppermost aquifer; therefore, lead and zinc will not be retained as constituents of interest in the site groundwater.

Toxicity factors used in the evaluation of risk associated with chromium are available for both trivalent (III) and hexavalent (VI) chromium. Toxicity factors are not available for chromium (total). Therefore, as hexavalent and chromium (total) were measured in unfiltered groundwater samples the percent distribution of unfiltered hexavalent chromium will be used to evaluate soluble chromium (total). This evaluation is presented in Section A2.6.

MW-9 and Plant Wells. No constituents were retained of interest in the groundwater from MW-9 and the plant wells. Though acetone was detected in MW-9 from the lower aquifer, and from plant well number 2, it was not retained as a constituent of interest as it is a common laboratory contaminant found in many blank samples and it was not detected in subsequent analyses (for MW-9). A trace amount of TCE was detected in plant well number 1. Due to the depth of the well (250 feet) and the substantial net upward hydraulic gradient between the lower and uppermost aquifer, TCE was not retained as a constituent of interest in the plant wells. There were no other detections of constituents of interest (see Section 5.4 of the RI report).

Background. In addition to on-site groundwater (soluble) from the uppermost aquifer, Table A2-7 presents the data for the site groundwater (soluble) from background locations in the uppermost aquifer. Only one constituent of interest was detected in the background groundwater, nickel at 8.8 $\mu\text{g/L}$. Risks will not be evaluated for background locations.

A2.4 Site Surface Water

Site surface water has been divided into four databases of interest: Riverdale Creek downstream of the Randall Textron plant, background Riverdale Creek (upstream of

the plant), restricted on-site surface water (which includes the sludge lagoon and outfall ditch west of Route 332), and the site ditches and swamp. The groupings of surface water are slightly different from that presented in the RI report (see Section 5.0 of the RI report). For purposes of the risk assessment, surface water samples collected on-site (i.e., all samples other than those in Riverdale Creek, which is not restricted for access to the public) were evaluated with respect to potential for access. The sludge lagoon and outfall ditch west of Route 332 are located within the fenced area near the on-site landfill (i.e., soils associated with the interim action area). This area has more restricted access than the site ditches and swamp located on the east side of Route 332, which are primarily located outside the site fences. An overall summary of the constituents detected in the four databases is presented in Table A2-8. A list of the samples which comprise each database is presented in Attachment I; the actual data are presented in Appendix D of the RI report. Surface water sample locations are shown on Figure 3-2 of the RI report. The data summaries for these surface water groups are discussed in the following paragraphs.

Riverdale Creek. Table A2-9 presents the data summary for the downstream Riverdale Creek surface water samples; background data are also presented on this table (see also Section 5.3 of the RI report for the background comparison for surface water). As noted in Table A2-9, six volatile organics were detected in downstream Riverdale Creek surface water. The most frequently detected VOCs were 1,2-dichloroethene (total) (17 of 17 samples) and trichloroethene (17 of 17 samples).

Six semivolatile organics were detected in low concentrations in the downstream Riverdale Creek surface water. All six were detected in SW-3, the one sample that was analyzed for semivolatile organics (see Sections 3.0 and 5.3 of the RI report). The six detected include bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, 2-chlorophenol, diethyl phthalate, n-nitrosodiphenylamine, and pentachlorophenol (see Table A2-9). Pesticides were not detected in the one downstream Riverdale Creek surface water sample (SW-3) that was analyzed for these constituents.

Of the inorganic constituents for which surface water was analyzed, there were ten inorganic constituents retained of interest after the RI data evaluation (see Table A2-9; see Section 5.3 of the RI report). Of these ten inorganic constituents,

TABLE A2-8

SUMMARY OF CONSTITUENTS DETECTED IN SURFACE WATER^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Downstream Riverdale Creek	Upstream Riverdale Creek (Background)	Site Ditches and Swamp ^b	Restricted On-Site ^b
VOLATILE ORGANICS				
Acetone	X ^c	X	X	-- ^d
Carbon Tetrachloride	--	--	X	--
1,2-Dichloroethene (total)	X	--	X	X
Methylene Chloride	X	--	--	--
Toluene	X	--	--	X
Trichloroethene	X	--	X	X
1,1,1-Trichloroethane	--	--	X	X
Trichlorofluoromethane	--	--	X	--
Vinyl Chloride	X	--	--	X
Xylene (total)	--	--	--	X
SEMIVOLATILE ORGANICS				
bis(2-Ethylhexyl)phthalate	X	NA	NA	--
Butyl benzyl phthalate	X	NA	NA	--
2-Chlorophenol	X	NA	NA	--
Diethyl phthalate	X	NA	NA	--
Di-n-octyl phthalate	--	NA	NA	X
n-Nitrosodiphenylamine	X	NA	NA	--
Pentachlorophenol	X	NA	NA	--
PESTICIDES/PCBs				
None Detected				
INORGANICS				
Aluminum	X	NA ^e	NA	--
Arsenic	E ^f	E	--	--
Barium	X	NA	NA	X
Calcium	E	E	E	E
Chromium (total)	X	X	X	X
Chromium (hexavalent)	X	--	--	X
Copper	X	NA	NA	X
Iron	X	X	X	X
Lead	X	--	X	X
Magnesium	E	E	E	E
Manganese	X	NA	NA	X

TABLE A2-8 (Continued)

SUMMARY OF CONSTITUENTS DETECTED IN SURFACE WATER^a

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Constituent	Downstream Riverdale Creek	Upstream Riverdale Creek (Background)	Site Ditches and Swamp ^b	Restricted On-Site ^b
Nickel	X	X	X	X
Potassium	E	E	E	E
Sodium	E	E	E	E
Zinc	--	--	X	X

^aAll samples were not analyzed for all classes of analytical parameters (see Section 3.0 of the RI report). If a constituent was completely eliminated from a database on the basis of the blank evaluations conducted during the RI (see Section 5.0 of the RI report), then it is not identified as a detected constituent on this table (i.e., not indicated with an "X"). Otherwise, all detected constituents are reflected on this table.

^bSite ditches and swamp are located east of Route 332. Restricted on-site surface water is the sludge lagoon and outfall ditch west of Route 332.

^cAn "X" indicates the constituent was detected in the soil database noted.

^dDashes (--) indicate the constituent was analyzed for (in at least one sample from within the database) but was not detected.

^eNA indicates the constituent was not analyzed for in any samples from within the database.

^fAn "E" indicates the constituent was detected but was eliminated upon completion of the RI data evaluation of background (see Section 5.0 of the RI report).

TABLE A2-9

DATA SUMMARY OF CONSTITUENTS IN RIVERDALE CREEK SURFACE WATER^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent Detected	Method Detection Limit	Downstream Riverdale Creek			Upstream Riverdale Creek Background		Retained? (Y/N)
		Frequency of Detection ^b (%)	Arithmetic Mean of Detected Constituents ^c	Range of Detected Values (Minimum- Maximum)	Range of Detected Values		
VOLATILE ORGANICS (µg/L)							
Acetone	5.0	1/17 (5.9)	11	11	6.0	Y	
1,2-Dichloroethene (total)	1.0	17/17 (100.0)	72	20 - 140	ND ^d	Y	
Methylene chloride	2.0	2/17 (11.8)	4.9	2.3 - 7.4	ND	Y	
Toluene	1.0	1/17 (5.9)	1.4	1.4	ND	Y	
Trichloroethene	1.0	17/17 (100.0)	220	40 - 570	ND	Y	
Vinyl chloride	2.0	3/17 (17.6)	14	13 - 14	ND	Y	
SEMIVOLATILE ORGANICS ^f (µg/L)							
bis(2-Ethylhexyl)phthalate	2.0	1/1 (100.0)	7.8	7.8	NA ^e	Y	
Butyl benzyl phthalate	2.0	1/1 (100.0)	0.5	0.5	NA	Y	
2-Chlorophenol	2.0	1/1 (100.0)	0.4	0.4	NA	Y	
Diethyl phthalate	2.0	1/1 (100.0)	0.1	0.1	NA	Y	
n-Nitrosodiphenylamine	2.0	1/1 (100.0)	0.4	0.4	NA	Y	
Pentachlorophenol	2.0	1/1 (100.0)	0.5	0.5	NA	Y	
PESTICIDES ^f (µg/L)							
Not Detected							
INORGANICS (µg/L)							
Aluminum	100	1/1 (100.0)	2,800	2,800	NA	Y	
Arsenic	5.0	1/17 (5.9)	10	10	ND	Y	
Barium	5.0	1/1 (100.0)	55	55	NA	Y	
Chromium (total)	2.0	17/17 (100.0)	271	83 - 969	3.0	Y	

TABLE A2-9 (Continued)

DATA SUMMARY OF CONSTITUENTS IN RIVERDALE CREEK SURFACE WATER^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent Detected	Method Detection Limit	Downstream Riverdale Creek			Upstream Riverdale Creek Background		Retained? (Y/N)
		Frequency of Detection ^b (%)	Arithmetic Mean of Detected Constituents ^c	Range of Detected Values (Minimum- Maximum)	Range of Detected Values		
Chromium (hexavalent)	25	7/16 (43.8)	69.9	26 - 129	ND	Y	
Copper	4.0	1/1 (100.0)	8.5	8.5	NA	Y	
Iron	3.0	4/4 (100.0)	4,570	2,170 - 6,720	5,620	Y	
Lead	3.0	4/17 (23.5)	5.4	4.2 - 6.8	ND	Y	
Manganese	2.0	1/1 (100.0)	264	264	NA	Y	
Nickel	7.0	7/17 (41.2)	9.56	7.4 - 14	9.3	Y	

^aData are presented only for those constituents retained of interest upon completion of the RI data evaluation for blanks and background comparisons (see Section 5.0 of the RI report). Surface water data is unfiltered. Data are presented in Appendix D of the RI report.

^bTotal number of samples may vary. Nondetect data is represented by one-half the detection limit. However, if one-half the detection limit exceeded the maximum detection, then the constituent-specific sample result was discounted and the total number of samples for that constituent was decreased by one.

^cArithmetic means were determined using normal statistics; means are rounded to two significant digits for organics and three significant digits for inorganics.

^dND indicates the constituent was not detected in any samples from the database of interest.

^eNA indicates the constituent was not analyzed for in the database of interest.

^fOnly one surface water sample from Riverdale Creek (SW-3) was analyzed for semivolatile organics and pesticides.

the most frequently detected were aluminum, barium, copper, and manganese, each detected in one of one sample, and iron (four detections in four samples).

Site Ditches and Swamp. Table A2-10 presents the data summary for the constituents detected in the surface water from the site ditches and swamp located east of Route 332. As noted in Table A2-10, six volatile organics were detected in the surface water from the site ditches and swamp. The most frequently detected VOCs were acetone and 1,1,1-trichloroethane, both detected in two of six samples.

The surface water from the site ditches and swamp east of Route 332 were not analyzed for semivolatile organics or pesticides/PCBs. These samples were analyzed for inorganic constituents. The most frequently detected inorganic was iron (four of four samples).

Restricted On-Site Surface Water. Table A2-11 presents the data summary for the constituents detected in the restricted on-site surface water, which includes the sludge lagoon and the outfall ditch west of Route 332. As noted in Table A2-11, six volatile organics were detected in the restricted on-site surface water. The most frequently detected VOCs were 1,2-dichloroethene (total) and trichloroethene, both detected in eight of eight samples.

Only one semivolatile organic, di-n-octyl phthalate (one of one sample) was detected in the restricted on-site surface water. Pesticides/PCBs were not detected in the one restricted on-site surface water sample (SW-1) which was analyzed for these compounds (see Sections 3.0 and 5.3 of the RI report).

The most frequently detected inorganics retained of interest in the restricted on-site surface water were barium, copper, and manganese (each detected in one of one sample) and chromium (total), detected in eight of eight samples.

A2.5 Sediment

Site sediment has been divided into four databases of interest, consistent with the surface water data (see Section A2.4): downstream Riverdale Creek, upstream (background) Riverdale Creek, restricted on-site sediment (which includes the sludge lagoon and outfall ditch west of Route 332), and the site ditches and swamp (east of

TABLE A2-10

DATA SUMMARY OF CONSTITUENTS IN SITE DITCHES AND SWAMP SURFACE WATER^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Method Detection Limit	Site Ditches and Swamp ^b			Retained? (Y/N)
		Frequency of Detection ^c (%)	Arithmetic Mean of Detected Constituents ^d	Range of Detected Values (Minimum- Maximum)	
VOLATILE ORGANICS (μg/L)					
Acetone	5.0	2/6 (33.3)	10	7.8 - 13	Y
Carbon tetrachloride	1.0	1/6 (16.7)	3.7	3.7	Y
1,2-Dichloroethene (total)	1.0	1/6 (16.7)	1.9	1.9	Y
1,1,1-Trichloroethane	1.0	2/6 (33.3)	1.5	0.8 - 2.1	Y
Trichloroethene	1.0	1/6 (16.7)	1.8	1.8	Y
Trichlorofluoromethane	2.0	1/6 (16.7)	9.0	9.0	Y
SEMIVOLATILE ORGANICS (μg/L)					
Not Analyzed					
PESTICIDES/PCBs (μg/L)					
**Not Analyzed					
INORGANICS (μg/L)					
Chromium (total)	2.0	2/5 (40.0)	3.1	2.8 - 3.4	Y
Iron	3.0	4/4 (100.0)	4100	1,970 - 8,940	Y
Lead	3.0	2/6 (33.3)	7.85	3.7 - 12	Y

TABLE A2-10 (Continued)

DATA SUMMARY OF CONSTITUENTS IN SITE DITCHES AND SWAMP SURFACE WATER^a

RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Method Detection Limit	Site Ditches and Swamp ^b			Retained? (Y/N)
		Frequency of Detection ^c (%)	Arithmetic Mean of Detected Constituents ^d	Range of Detected Values (Minimum- Maximum)	
Nickel	7.0	2/6 (33.3)	12.3	8.5 - 16	Y
Zinc	7.0	1/6 (16.7)	86	86	Y

^aData are presented only for those constituents retained of interest upon completion of the RI data evaluation for blanks and background comparisons (see Section 5.0 of the RI report). Surface water data is unfiltered. Site ditches and swamp are located east of Route 332. Data are presented in Appendix D of the RI report.

^bThere were no background surface water samples available for the site ditches and swamp.

^cTotal number of samples may vary. Nondetect data is represented by one-half the detection limit. However, if one-half the detection limit exceeded the maximum detection, then the constituent-specific sample result was discounted and the total number of samples for that constituent was decreased by one.

^dArithmetic mean was determined using normal statistics; means are rounded to two significant digits for organics and three significant digits for inorganics.

TABLE A2-11

DATA SUMMARY OF CONSTITUENTS IN RESTRICTED ON-SITE SURFACE WATER^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Method Detection Limit	Restricted On-Site Surface Water ^b			Retained? (Y/N)
		Frequency of Detection (%)	Arithmetic Mean of Detected Constituents ^c	Range of Detected Values (Minimum- Maximum)	
VOLATILE ORGANICS (µg/L)					
1,2-Dichloroethene (total)	1.0	8/8 (100.0)	58	3.2 - 98	Y
Toluene	1.0	4/8 (50.0)	1.7	1.4 - 2.0	Y
1,1,1-Trichloroethane	1.0	1/8 (12.5)	1.0	1.0	Y
Trichloroethene	1.0	8/8 (100.0)	89	4.4 - 130	Y
Vinyl chloride	2.0	1/8 (12.5)	6.2	6.2	Y
Xylene (total)	2.0/1.0 ^d	3/8 (37.5)	1.2	1.1 - 1.4	Y
SEMIVOLATILE ORGANICS (µg/L)					
Di-n-octyl phthalate	2.0	1/1 (100.0)	0.3	0.3	Y
PESTICIDES/PCBs (µg/L)					
None Detected					
INORGANICS (µg/L)					
Barium	5.0	1/1 (100.0)	92	92	Y
Chromium (total)	2.0	8/8 (100.0)	492	141 - 681	Y
Hexavalent chromium	25	3/8 (37.5)	140	85 - 172	Y
Copper	4.0	1/1 (100.0)	9.0	9.0	Y
Iron	3.0	1/4 (25.0)	539	539	Y
Lead	3.0	5/8 (62.5)	47.8	3.9 - 188	Y

TABLE A2-11 (Continued)

DATA SUMMARY OF CONSTITUENTS IN RESTRICTED ON-SITE SURFACE WATER^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Method Detection Limit	Restricted On-Site Surface Water ^b			Retained? (Y/N)
		Frequency of Detection (%)	Arithmetic Mean of Detected Constituents ^c	Range of Detected Values (Minimum- Maximum)	
Manganese	2.0	1/1 (100.0)	27	27	Y
Nickel	7.0	4/8 (50.0)	11.6	7.7 - 19	Y
Zinc	7.0	1/8 (12.5)	22	22	Y

^aData are presented only for those constituents retained of interest upon completion of the RI data evaluation for blanks and background comparisons (see Section 5.0 of the RI report). Surface water data is unfiltered. Restricted on-site surface water includes the sludge lagoon and outfall ditch. Data are presented in Appendix D of the RI report.

^bThere were no background surface water samples available for the sludge lagoon and outfall ditch.

^cArithmetic mean was determined using normal statistics; means are rounded to two significant digits for organics and three significant digits for inorganics.

^dThe method detection limit for xylene (total) changed from 2.0 µg/L to 1.0 µg/L in 1993.

Route 332). An overall summary of the constituents detected in the four databases is presented in Table A2-12. A list of the samples which comprise each database is presented in Attachment I. The actual data are presented in Appendix D of the RI report. Sediment sample locations are shown on Figure 3-2 of the RI report. The data summaries for these sediment groups are presented in the following paragraphs.

Riverdale Creek. Table A2-13 presents the data summary for the downstream Riverdale Creek sediment samples, as well as the upstream (background) data. As noted in Table A2-13 three volatile organics were detected in downstream Riverdale Creek sediment. The most frequently detected VOC was trichloroethene (three of five samples).

One semivolatile organic, bis(2-ethylhexyl)phthalate, was detected at 0.05 mg/kg in downstream Riverdale Creek sediment. Pesticides were not detected in the one Riverdale Creek sediment sample (SED-3) that was analyzed for these constituents (see Sections 3.0 and 5.3 of the RI report).

There were four inorganic constituents retained of interest after the RI data evaluation of background levels: chromium (total), lead, nickel, and zinc (see Table A2-13; see Section 5.3 of the RI report). Of these four inorganic constituents, the most frequently detected were chromium and zinc, each detected in five of five samples.

Site Ditches and Swamp. Table A2-14 presents the data summary for the constituents detected in sediment from the site ditches and swamp located east of Route 332. Acetone was the only volatile organic detected in the sediment from these locations; acetone was detected in three of six samples. The sediment samples from the site ditches and swamp were not analyzed for semivolatile organics or pesticides/PCBs.

Per the RI data evaluation, soil UTLs were used to evaluate sediment concentrations from the swamp and site ditches. Four inorganic constituents detected in the site ditch and swamp sediment were retained upon completion of the RI data evaluation of background levels, i.e., chromium (total), lead, nickel, and zinc (see Section 5.3 of the RI report). Of these four constituents, nickel (with a

TABLE A2-12

SUMMARY OF SITE CONSTITUENTS DETECTED IN SEDIMENT^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Downstream Riverdale Creek	Upstream Riverdale Creek (Background)	Site Ditches and Swamp ^b	Restricted On-Site ^b
VOLATILE ORGANICS				
Acetone	-- ^c	--	X ^d	X
1,2-Dichloroethene (total)	X	--	--	X
Methylene Chloride	X	--	--	--
Trichloroethene	X	--	--	X
Tetrachloroethene	--	--	--	X
Xylene (total)	--	--	--	X
SEMIVOLATILE ORGANICS				
bis(2-Ethylhexyl)phthalate	X	NA ^e	NA	X
Fluoranthene	--	NA	NA	X
Isophorone	--	NA	NA	X
Phenanthrene	--	NA	NA	X
PESTICIDES/PCBs				
None Detected				
INORGANICS				
Aluminum	E ^f	NA	NA	E
Antimony	--	NA	NA	X
Arsenic	E	E	E	E
Barium	E	NA	NA	X
Beryllium	--	NA	NA	E
Cadmium	--	NA	NA	E
Calcium	E	NA	NA	E
Chromium	X	X	X	X
Cobalt	E	NA	NA	E
Copper	E	NA	NA	X
Iron	E	NA	NA	E
Lead	X	X	X	X
Magnesium	--	NA	NA	E
Manganese	E	NA	NA	E
Mercury	--	NA	NA	E
Nickel	X	X	X	X
Potassium	E	NA	NA	E
Silver	--	NA	NA	E

TABLE A2-12 (Continued)

SUMMARY OF SITE CONSTITUENTS DETECTED IN SEDIMENT^a

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Constituent	Downstream Riverdale Creek	Upstream Riverdale Creek (Background)	Site Ditches and Swamp ^b	Restricted On-Site ^b
Sodium	E	NA	NA	E
Vanadium	E	NA	NA	E
Zinc	X	X	X	X

^aAll samples were not analyzed for all classes of analytical parameters (see Section 3.0 of the RI report). If a constituent was completely eliminated from a database on the basis of the blank evaluations conducted during the RI (see Section 5.0 of the RI report), then it is not identified as a detected constituent on this table (i.e., not indicated with an "X"). Otherwise, all detected constituents are reflected on this table.

^bSite ditches and swamp are located east of Route 332. Restricted on-site surface water is the sludge lagoon and outfall ditch west of Route 332.

^cDashes (--) indicate the constituent was analyzed for (in at least one sample from within the database) but was not detected.

^dAn "X" indicates the constituent was detected in the soil database noted.

^eNA indicates the constituent was not analyzed for in any samples from within the database.

^fAn "E" indicates the constituent was detected but eliminated upon completion of the RI data evaluation of background (see Section 5.0 of the RI report).

TABLE A2-13

DATA SUMMARY OF CONSTITUENTS IN RIVERDALE CREEK SEDIMENT^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Method Detection Limit	Downstream Riverdale Creek			Upstream Riverdale Creek		Retained? (Y/N)
		Frequency of Detection (%)	Arithmetic Mean of Detected Constituents ^b	Range of Detected Values (Minimum- Maximum)	Range of Detected Values		
VOLATILE ORGANICS							
1,2-Dichloroethene (total)	1.0	1/5 (20.0)	55	55	ND ^c	Y	
Methylene chloride	2.0	2/5 (40.0)	2.6	1.7 - 3.4	ND	Y	
Trichloroethene	1.0	3/5 (60.0)	44	0.9 - 130	ND	Y	
SEMIVOLATILE ORGANICS ^d (mg/kg)							
bis(2-Ethylhexyl)phthalate	0.07	1/1 (100.0)	0.05	0.05	NA ^e	Y	
PESTICIDES (mg/kg)							
Not Detected ^d							
INORGANICS (mg/kg)							
Chromium (total)	0.2	5/5 (100.0)	14.7	4.8 - 31	3.4 - 3.7	Y	
Lead	2.0	2/5 (40.0)	7.1	3.2 - 11	2.6	Y	
Nickel	0.7	4/5 (80.0)	4.2	1.1 - 13	1.6 - 1.8	Y	
Zinc	0.7	5/5 (100.0)	11.3	3.2 - 42	3.1 - 5.2	Y	

^aData are presented only for those constituents retained of interest upon completion of the RI data evaluation for blanks and background comparisons (see Section 5.0 of the RI report).
Data are presented in Appendix D of the RI report.

^bArithmetic means were determined using normal statistics; means are rounded to two significant digits for organics and three significant digits for inorganics.
^cND indicates the constituent was not detected in any samples from the database of interest.

^dOnly one sediment water sample from Riverdale Creek (SD-3) was analyzed for semivolatiles and pesticides.

^eNA indicates the constituent was not analyzed for in the database of interest.

TABLE A2-14

DATA SUMMARY OF CONSTITUENTS IN SITE DITCHES AND SWAMP SEDIMENT^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Method Detection Limit	Site Ditches and Swamp			Background ^b		Retained? (Y/N)	Reason for Exclusion/Remarks
		Frequency of Detection (%)	Arithmetic Mean of Detected Constituents ^c	Range of Detected Values (Minimum- Maximum)	Soil UTLs			
VOLATILE ORGANICS (µg/kg)								
Acetone	5.0	3/6 (50.0)	61	48 - 68	..d		Y	
SEMIVOLATILE ORGANICS (µg/kg)								
Not Analyzed								
PESTICIDES/PCBs (µg/kg)								
Not Analyzed								
INORGANICS (mg/kg)								
Chromium (total)	0.20	6/6 (100.0)	141	25 - 362	65.63		Y	
Lead	2.0	6/6 (100.0)	49.7	14 - 100	39.43		Y	
Nickel	0.70	6/6 (100.0)	22.6	9.5 - 38	38.04		N	Maximum measured less than UTL
Zinc	0.70	6/6 (100.0)	133	41 - 221	111.19		Y	

^aData are presented only for those constituents retained of interest upon completion of the RI data evaluation for blanks and background comparisons (see Section 5.0 of the RI report). Site ditches and swamp are located east of Route 332. Data are presented in Appendix D of the RI report.

^bThere were no background samples available for the site ditches and swamp. The inorganic concentrations are compared to upper tolerance limits (UTLs) which are based on background soil samples (see Section 5.0 of the RI report).

^cArithmetic mean was determined using normal statistics; means are rounded to two significant digits for organics and three significant digits for inorganics.

^dDashes (-) indicate no information was available.

maximum value of 38 mg/kg) was present at concentrations less than its respective soil UTL of 38.04 mg/kg. Therefore, nickel will not be retained as a constituent of interest in the sediment from the site ditches and swamp east of Route 332 (see Table A2-14).

Restricted On-Site Sediment. Table A2-15 presents the data summary for the constituents detected in the restricted on-site sediment from the sludge lagoon and the outfall ditch located west of Route 332. As noted in Table A2-15, five volatile organics were detected in the sediment from these locations. The most frequently detected volatile organic was trichloroethene, which was detected in four of four samples.

Four semivolatile organics were detected in the one sediment sample that was analyzed for this class of compounds (SED-1 from the sludge lagoon). The detected semivolatile organics included bis(2-ethylhexyl)phthalate, fluoranthene, isophorone, and phenanthrene. SED-1 was the only sediment sample from the sludge lagoon and outfall ditch which was analyzed for pesticides/PCBs. No pesticides or PCBs were detected in SED-1 (see Sections 3.0 and 5.3 of the RI report).

Per the RI data evaluation of background levels, soil UTLs were used to evaluate sediment concentrations of arsenic, chromium (total), lead, nickel and zinc from the sludge lagoon and outfall ditch. The remaining constituents detected in sample SED-1, which was evaluated for the TAL metals, were compared to typical ranges of inorganic concentrations in native soils (see Section 5.3 of the RI report). Seven inorganics were retained in the restricted on-site sediment all of which were detected at a 100 percent frequency of detection: antimony, barium, and copper were each detected in one of one sample, and chromium (total), lead, nickel, and zinc were each detected in four of four samples (see Table A2-15).

A2.6 EVALUATION OF CHROMIUM DISTRIBUTION

All groundwater samples from the uppermost aquifer were analyzed for total (III and VI) chromium and hexavalent chromium in the unfiltered groundwater samples. This was done because toxicity factors used in the evaluation of risk associated with chromium are available for both trivalent (III) and hexavalent (VI) chromium. Toxicity factors are not available for chromium (total). Though the RI

TABLE A2-15

DATA SUMMARY OF CONSTITUENTS IN RESTRICTED ON-SITE SEDIMENT^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Method Detection Limit ^b	Restricted On-Site Sediment			Background		Retained? (Y/N)
		Frequency of Detection ^c (%)	Arithmetic Mean of Detected Constituents ^d	Range of Detected Values (Minimum- Maximum)	Typical Range In Soil or UTLs		
VOLATILE ORGANICS (μg/kg)							
Acetone	5.0	1/3 (33.3)	36	36	.f		Y
1,2-Dichloroethene (total)	1.0	3/4 (75.0)	370	28 - 1,000	--		Y
Tetrachloroethene	1.0	2/4 (50.0)	550	4.2 - 1,100	--		Y
Trichloroethene	1.0	4/4 (100.0)	600	7.1 - 1,900	--		Y
Xylene (total)	2.0/1.0	1/4 (25.0)	2,200	2,200	--		Y
SEMIVOLATILE ORGANICS (mg/kg)							
bis(2-Ethylhexyl)phthalate	2.0	1/1 (100.0)	120	120	--		Y
Fluoranthene	2.0	1/1 (100.0)	4.4	4.4	--		Y
Isophorone	2.0	1/1 (100.0)	2.4	2.4	--		Y
Phenanthrene	2.0	1/1 (100.0)	3.0	3.0	--		Y
PESTICIDES/PCBs ^g (mg/kg)							
None Detected							
INORGANICS (μg/L)							
Antimony	1.0	1/1 (100.0)	41	41	<1.0 - 8.8 ^h		Y
Barium	0.25	1/1 (100.0)	1,730	1,730	10 - 1,500; 150 - 700 ^h		Y
Chromium (total)	0.10/0.20	4/4 (100.0)	37,500	405 - 132,000	65.63		Y
Copper	0.20	1/1 (100.0)	888	888	<1.0 - 700; 3.0 - 50 ^h		Y

TABLE A2-15 (Continued)

DATA SUMMARY OF CONSTITUENTS IN RESTRICTED ON-SITE SEDIMENT^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Method Detection Limit ^b	Restricted On-Site Sediment			Background ^c		Retained? (Y/N)
		Frequency of Detection ^c (%)	Arithmetic Mean of Detected Constituents ^d	Range of Detected Values (Minimum- Maximum)	Typical Range In Soil or UTLs		
Lead	5.0/2.0	4/4 (100.0)	448	12 - 1,350	39.43		Y
Nickel	0.35/0.70	4/4 (100.0)	221	13 - 581	38.04		Y
Zinc	0.35/0.70	4/4 (100.0)	205	31 - 524	111.19		Y

^aData are presented only for those constituents retained of interest upon completion of the RI data evaluation for blanks and background comparisons (see Section 5.0 of the RI report). Restricted on-site sediment includes the sludge lagoon and outfall ditch west of Route 332. Data are presented in Appendix D of the RI report.

^bDetection limits varied. The detection limit for xylene (total) change from 2.0 µg/kg to 1.0 µg/kg in 1993.

^cTotal number of samples may vary. Nondetect data is represented by one-half the detection limit. However, if one-half the detection limit exceeded the maximum detection, then the constituent-specific sample result was discounted and the total numbers of samples for that constituent was decreased by one.

^dArithmetic means were determined using normal statistics; means are rounded to two significant digits for organics and three significant digits for inorganics.

^eThere were no background sediment samples for the sludge lagoon and outfall ditch. The inorganic concentrations are compared to upper tolerance limits (UTLs) for soil chromium, lead, nickel, and zinc. The remaining constituents are compared to typical ranges in native soils (see Sections 5.2 and 5.3 of the RI report).

^fDashes (-) indicate no information was available.

^gPesticides/PCBs were not detected in the one sediment sample (SED-1) analyzed.

^hThe first range represents Eastern U.S. soils; the second range represents Mississippi soils (see Table 5-2 of the RI report).

data evaluation indicated that unfiltered concentrations of inorganics were not representative of site concentrations due to the presence of high levels of sediment (see Section 5.4.1 of the RI report), the unfiltered total and hexavalent chromium results were evaluated to determine a percentage distribution of chromium in the hexavalent and trivalent (III) states to be used to represent soluble chromium (total) in groundwater from the uppermost aquifer.

Table A2-16 presents the analytical results for total chromium and hexavalent chromium (unfiltered) for the samples in which both constituents were detected (this evaluation does not include data from samples where only one of the two constituents was detected). As noted in Table A2-16, the average percentage distribution for the eight groundwater samples where both total chromium and hexavalent chromium (unfiltered) were detected is 46.7 percent hexavalent chromium. Therefore, this distribution, i.e., 47 percent hexavalent chromium and an assumed value of 53 percent trivalent chromium, will be used to quantify potential risks associated with the soluble chromium data obtained for groundwater from the uppermost aquifer.

All surface water samples (unfiltered) were analyzed for total chromium and hexavalent chromium. These results were evaluated to determine a percent distribution of chromium in the hexavalent and trivalent states to be used in the evaluation of risk associated with chromium in surface water. There were seven surface water samples from Riverdale Creek with detected concentrations of both total and hexavalent chromium. As shown in Table A2-16, the average hexavalent chromium for Riverdale Creek was 56.3 percent. Therefore, for the quantification of potential risks associated with Riverdale Creek surface water samples, a 56 percent hexavalent chromium and an assumed 44 percent trivalent chromium distribution will be used (see Table A2-16).

As shown in Table A2-16, there were three samples from the site ditches that had reported concentrations for both total and hexavalent chromium. The average hexavalent chromium for the site ditches was 32.6 percent. Therefore, for the quantification of potential risks associated with surface water from the site ditches and swamp, a 33 percent hexavalent chromium and an assumed 67 percent trivalent chromium distribution will be used (see Table A2-16). This distribution

TABLE A2-16

**PERCENT DISTRIBUTION OF UNFILTERED HEXAVALENT CHROMIUM IN
GROUNDWATER AND SURFACE WATER^a**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Sample ID and Location	Unfiltered Chromium Concentration (μg/L)		Hexavalent Chromium (%)
	Total (III and VI)	Hexavalent (VI)	
Uppermost Aquifer ^{b,c}			
MW-14	343	50	14.6
MW-11	251	30	12.0
MW-23S	1,230	210	17.1
MW-3	95	60	63.2
MW-16	90	60	66.7
RT-2	20,100	18,000	89.6
RT-3	58,800	51,000	86.7
MW-23	1,180	279	23.6
		Average Percent:	46.7
Downstream Riverdale Creek ^{c,d}			
SW-9	169	32	18.9
SW-17A	84	35	41.7
SW-17B	83	26	31.3
SW-18B	166	36	21.7
SW-19A	119	129	100.0 ^e
SW-19B	126	115	91.3
SW-19C	130	116	89.2
		Average Percent:	56.3

TABLE A2-16 (Continued)

**PERCENT DISTRIBUTION OF UNFILTERED HEXAVALENT CHROMIUM IN
GROUNDWATER AND SURFACE WATER^a**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Sample ID and Location	Unfiltered Chromium Concentration (μg/L)		Hexavalent Chromium (%)
	Total (III and VI)	Hexavalent (VI)	
Site Ditches ^{c,f}			
SW-12	431	164	38.1
SW-10	410	85	20.7
SW-11	441	172	39.0
Average Percent:			32.6

^aOnly samples with detections of both chromium (total) and hexavalent chromium are presented.

^bHexavalent chromium was not detected in groundwater from background locations in the uppermost aquifer, the lower aquifer (i.e., MW-9), or the deeper water-bearing units (i.e., the plant wells).

^cData is presented in Appendix D of the RI report.

^dHexavalent chromium was not detected in background (i.e., upstream) locations in Riverdale Creek. Only downstream locations are represented.

^eIt is assumed that hexavalent chromium represents 100 percent of the total chromium for this sample.

^fHexavalent chromium was not detected in surface water from the outfall ditch, sludge lagoon, or swamp.

will also be used to quantify potential risks associated with restricted on-site surface water, (i.e., the sludge lagoon and outfall ditch).

Chromium in soil and sediment was measured only as total chromium. As noted previously, however, toxicity factors are only available for trivalent and hexavalent chromium. Therefore in the evaluation of risk associated with chromium in soil and sediment, a range of risk assuming 100 percent trivalent chromium and 100 percent hexavalent chromium will be presented (see Section A6.0).

A3.0 EXPOSURE ASSESSMENT

Using the information generated in the RI report, this section presents the components of potential human exposure pathways, including a description of potential migration pathways associated with each medium of interest at the site, presentation of exposure concentrations, and a brief discussion of potential human receptor populations.

A3.1 COMPONENTS OF POTENTIAL EXPOSURE PATHWAYS

The identification of potential exposure pathways is accomplished for each environmental medium of interest at the site (soils, groundwater, surface water and sediment, non-aqueous phase liquids, and air). In the risk assessment process, only "complete" pathways may be quantified. An exposure pathway may be viewed as complete if it consists of four elements: (1) a source and mechanism of release to the environment; (2) an environmental transport medium (e.g., air, groundwater); (3) a point of potential contact between a receptor and the environmental medium (referred to as exposure concentrations); and (4) an exposure route (e.g., inhalation, ingestion) at the exposure point. The exposure pathway evaluation is accomplished by describing actual or potential exposure scenarios which involve the above elements. An overview of each of these components of the exposure assessment is presented below.

A3.1.1 Calculation of Potential Exposure Concentrations

Potential exposure concentrations were determined in accordance with Region IV supplemental guidance (USEPA Region IV, 1992), as described below. Actual sample analytical data used to calculate potential exposure concentrations are presented in Appendix D of the RI report; lists which identify which samples are associated with the specific databases evaluated in the risk assessment are presented in Attachment I.

According to the Region IV supplemental guidance (USEPA Region IV, 1992), the potential exposure concentrations should be the upper 95th percent confidence limits (UCLs) of the arithmetic mean of log-transformed data for a given constituent, as shown:

$$UCL = e^{\left(\bar{x} + 0.5s^2 + \frac{sH}{\sqrt{n-1}} \right)}$$

where:

UCL = upper 95th percent confidence limit on the arithmetic mean

e = natural log

\bar{x} = the mean of the log-transformed data

s = the standard deviation of the log-transformed data

n = sample size

H = statistic (interpolated from "Tables of Confidence Limits for Linear Functions of the Normal Mean and Variance" (Land, 1975)

Per the Region IV supplemental guidance (USEPA Region IV, 1992), to calculate UCLs, sample data should be log-transformed; therefore, a lognormal distribution of data was assumed. The arithmetic mean and the standard deviation of the log-transformed data were then calculated. All qualified data were included in the arithmetic mean using the assigned values that were described in Section A2.0 (i.e., all J-, B-, D-, and E-qualified data were used as reported; one-half the detection limit was used to represent U- and UD-qualified data, and one-half the reported concentration was used to represent X-qualified data). H values were interpolated from "Tables of Confidence Limits for Linear Functions of the Normal Mean and Variance" (Land, 1975), and UCLs were calculated per the equation previously given. UCLs for each constituent were then compared to the maximum detected concentration of the constituent in the same medium (see medium-specific data tables in Sections A2.2 through A2.5 for maximum detections). Per the Region IV supplemental guidance (USEPA Region IV, 1992), if the UCL was less than the maximum concentration, it was used as the potential exposure concentration; if the UCL was greater than the maximum concentration, then the maximum concentration was used as the potential exposure concentration. The potential

exposure concentrations calculated for each medium of interest are presented within the pathway-specific sections, (e.g., potential exposure concentrations for soils are presented within Section A3.2, Soil Pathway).

A3.1.2 Overview of Potential Sources and Release Mechanisms

Table A3-1 is a summary of potential migration pathways believed to exist at the Randall Textron Plant site. In the absence of site remediation (i.e., under baseline conditions), these potential migration pathways may also be expected to be relevant in the future. Each migration pathway is described in terms of potential source (or type of source), a potential release mechanism, and a potential receiving medium.

The original objective of this RI was to investigate the impacts to site media from the on-site landfill at the Randall Textron Plant site. However, during the course of this investigation other possible sources of impacts were identified. These include the following (see Section 2.3.1 of the RI report): on-site landfill; equalization lagoon; sludge lagoon; chromium reduction unit, raw waste station/wet well, and process sewers; outfall ditch; former toluene storage area; former trichloroethene storage area; and former burn area. Only those sources which have been identified through the RI site evaluation as significant sources of constituents of interest or are relevant to potential human receptors are discussed in this section (see Section 7.0 of the RI report). For the purposes of evaluating potentially significant migration pathways of site constituents relative to human receptors, the significant site sources were grouped together. Sources were grouped based on proximity of the sources to one another (i.e., if contribution from each cannot be distinguished and/or accessibility to potential receptors. At the Randall Textron plant site, four primary sources have been identified:

- the on-site landfill associated wastes (and soil), and sludge lagoon (by virtue of proximity)
- the former solvent (TCE and toluene) storage areas
- the chromium reduction unit
- the plant outfall and ditch

TABLE A3-1

SUMMARY OF POTENTIAL MIGRATION PATHWAYS^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Potential Source	Potential Release Mechanism	Potential Receiving Medium	Remarks	Location of Discussion
1. On-Site Landfill Associated Wastes and Soil, and Sludge Lagoon	Volatilization	Localized Air	Not a significant release mechanism based on ambient air survey	A3.6.2.1
	Fugitive Dust	Localized Air	Currently not a significant release mechanism; if disturbance of surficial soils were to occur then this mechanism may become significant	A3.6.2.2
	Leaching	Localized Subsurface Soils	Potentially significant release mechanism	A3.2.2.1
	Erosion/runoff	Localized Surficial Soils	Not expected to be a significant release mechanism due to minimal site relief and vegetative cover; occurs to minor degree at southernmost edge of landfill	A3.2.2.2
	Erosion/runoff	Surface Water --Riverdale Creek --site ditches --swamp	Not expected to be a significant release mechanism due to minimal site relief and vegetative cover	A3.4.2.1
(localized subsurface soils) ^b	(leaching)	(groundwater in uppermost aquifer)	Potentially significant release mechanism, especially for volatile organics	A3.3.2.1
(groundwater in uppermost aquifer)	(advection and dispersion)	(groundwater in lower aquifer)	Not expected to be a significant release mechanism due to presence of confining clay/shale unit and upward component to groundwater flow	A3.3.2.2
	(volatilization)	(localized air)	Not a potentially significant release mechanism under current site conditions. Volatilization may occur in the future if the uppermost aquifer is used as a domestic water supply.	A3.6.2.5
(groundwater in lower aquifer)	(advection and dispersion)	(groundwater in deeper water-bearing units)	Not expected to be a significant release mechanism due to presence of second confining clay unit and upward component to groundwater flow from lower aquifer	A3.3.2.3

TABLE A3-1 (Continued)

SUMMARY OF POTENTIAL MIGRATION PATHWAYS^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Potential Source	Potential Release Mechanism	Potential Receiving Medium	Remarks	Location of Discussion
(groundwater in uppermost aquifer)	(groundwater discharge)	(surface water --Riverdale Creek --site ditches)	Potentially significant release mechanism to Riverdale Creek and occasionally to the western portion of the outfall ditch	A3.4.2.2
(surface water)	(sorption)	(sediments)	Potentially significant release mechanism for inorganics	A3.4.2.3
	(groundwater recharge)	(groundwater in uppermost aquifer)	Potentially significant release mechanism for eastern portion of outfall ditch, equalization lagoon, and site ditches and swamp	A3.3.2.4
	(volatilization)	(localized air)	Potentially significant release mechanism for volatile organics in surface water from Riverdale Creek, site ditches and swamp, and outfall ditch	A3.6.2.3
(sediments)	(volatilization)	(localized air)	Not a potentially significant release mechanism under current site conditions; may become significant in the future if sediments are disturbed	A.3.6.2.4
2. Releases from Former Solvent (TCE and Toluene) Storage Areas	Volatilization	Localized Air	Not a potentially significant release mechanism under current site conditions (soils under pavement)	A3.6.2.1
	Fugitive Dust	Localized Air	Not a potentially significant release mechanism under current site conditions (soils under pavement)	A3.6.2.2
	Direct Release	NAPL (LNAPL and DNAPL)	Potentially significant release mechanism resulting in LNAPL (toluene) and DNAPL (TCE)	A3.5.2.1
	Leaching (historical)	Localized Subsurface Soils	Potentially significant release mechanism prior to pavement installation	A3.2.2.1
	Erosion/Runoff	Localized Surficial Soils	Not a potentially significant release mechanism under current site conditions (soils under pavement)	A3.2.2.2
	Erosion/Runoff	Surface Water --Riverdale Creek --site ditches --swamp	Not a potentially significant release mechanism under current site conditions (soils under pavement)	A3.4.2.1

TABLE A3-1 (Continued)
SUMMARY OF POTENTIAL MIGRATION PATHWAYS^a
RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Potential Source	Potential Release Mechanism	Potential Receiving Medium	Remarks	Location of Discussion
(LNAPL and DNAPL)	(dissolution)	(groundwater in uppermost aquifer)	Potentially significant release mechanism, particularly for toluene and TCE	A3.3.2.5
(localized subsurface soils)	(leaching) (historical)	(groundwater in uppermost aquifer)	Potentially significant release mechanism, especially for volatile organics, prior to pavement installation	A3.3.2.1
(groundwater in uppermost aquifer)	(advection and dispersion)	(groundwater in lower aquifer)	Not expected to be a significant release mechanism due to presence of confining clay/shale unit and upward component to groundwater flow	A3.3.2.2
	(volatilization)	(localized air)	Not a potentially significant release mechanism under current site conditions. Volatilization may occur in the future if the uppermost aquifer is used as a domestic water supply.	A3.6.2.5
(groundwater in lower aquifer)	(advection and dispersion)	(groundwater in deeper water-bearing units)	Not expected to be a significant release mechanism due to presence of second confining clay unit and upward component to groundwater flow	A3.3.2.3
(groundwater in uppermost aquifer)	(groundwater discharge)	(surface water --Riverdale Creek --site ditches)	Potentially significant release mechanism to Riverdale Creek and occasionally to the western portion of the outfall ditch	A3.4.2.2
(surface water)	(sorption)	(sediments)	Potentially significant release mechanism for inorganics	A3.4.2.3
	(groundwater recharge)	(groundwater in uppermost aquifer)	Potentially significant release mechanism for eastern portion of outfall ditch, other site ditches, sludge lagoon, equalization lagoon and swamp	A3.3.2.4
	(volatilization)	(localized air)	Potentially significant release mechanism for volatile organics in surface water from Riverdale Creek, site ditches, swamp, sludge lagoon, and outfall ditch	A3.6.2.3

TABLE A3-1 (Continued)
SUMMARY OF POTENTIAL MIGRATION PATHWAYS^a
RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Potential Source	Potential Release Mechanism	Potential Receiving Medium	Remarks	Location of Discussion
(sediments)	(volatilization)	(localized air)	Not a potentially significant release mechanism under current site conditions; may become significant in the future if sediments are disturbed	A.3.6.2.4
3. Chromium Reduction Unit (raw waste station, wet well, sewers, equalization lagoon)	Indirect Releases	Localized Subsurface Soil	Potentially significant release mechanism for chromium	A.3.2.2.3
(localized subsurface soil)	(leaching)	(groundwater in uppermost aquifer)	Potentially significant release mechanism for chromium	A.3.3.2.1
4. Plant Outfall and ditch	Direct Release	Surface Water --outfall ditch	Potentially significant release mechanism for outfall ditch	A.3.4.2.4
(surface water --outfall ditch)	(sorption)	(sediment --outfall ditch)	Potentially significant release mechanism for inorganics in outfall ditch	A.3.4.2.3
(surface water and sediment -- outfall ditch)	(downstream transport)	(surface water and sediment --Riverdale Creek)	Potentially significant release mechanism	A.3.4.2.5
(surface water)	(volatilization)	(localized air)	Potentially significant release mechanism for volatile organics in surface water from Riverdale Creek and outfall ditch	A3.6.2.3
(sediments)	(volatilization)	(localized air)	Not a potentially significant release mechanism under current site conditions; may become significant in the future if sediments are disturbed	A3.6.2.4

^aOnly the potential migration pathways from sources identified as potentially significant during the RI (see Section 7.0) are presented on this table.

^bAll primary pathways originate from the primary source (e.g., the on-site landfill). Parentheses indicate secondary or indirect sources, release mechanisms, and receiving media. See text for complete discussion of potential migration pathways.

The chromium reduction unit was considered to include the raw waste station, wet well, process sewers, and, by virtue of proximity, the equalization lagoon. In addition, the non-aqueous phase liquids (LNAPL and DNAPL) which have been identified at the site are considered to be a secondary source of constituents of interest, most likely originating from the former solvent storage areas.

The on-site landfill was used by the facility from 1961 through 1967 for disposal of waste generated from plant processes (see Section 2.1 of the RI report). The former solvent storage area includes the area of the former underground toluene storage tank which was removed in 1988, and the former TCE storage area where TCE was stored in above ground storage tanks; associated former underground piping is also included (see Section 2.3.1 of the RI report). Prior to 1991, chromium electroplating wastewater was treated in a chromium reduction unit prior to discharge to the equalization lagoon and wet well. The chromium reduction unit reduces hexavalent chromium (Cr^{+6}) to trivalent chromium (Cr^{+3}), and is located on the north side of the main plant building. The raw waste station, or wet well, is a pump sump for transfer of untreated wastewater to the wastewater treatment plant. The process sewers routed all untreated wastewater from the process areas to the equalization lagoon (prior to 1991) and/or the wet well, and then to the wastewater treatment plant. In 1991, all wastewater was diverted directly to the wastewater treatment facility (see Sections 2.1 and 2.3.1 of the RI report). The plant outfall consists of the NPDES-regulated discharges from the wastewater treatment plant (see Section 2.3.1 of the RI report). The outfall ditch receives the NPDES-regulated discharges from the wastewater treatment plant. Water in the outfall ditch flows west and into Riverdale Creek. The permit contains limitations and routine monitoring requirements for several inorganics, including total chromium, hexavalent chromium, cadmium, copper, lead, nickel, silver, zinc, and cyanide. Over the years some volatile organic compounds have been detected in the discharge, including trichloroethene, toluene, 1,1,1-trichloroethane, 1,2-dichloroethene, and methylene chloride. (see Section 2.3.1.5 of the RI report).

Collectively, the primary pathways by which constituents may potentially migrate from the primary site sources to other media include: volatilization, fugitive dust emissions, leaching, erosion/runoff, direct releases, and indirect releases. All other potential migration pathways presented in Table A3-1 are believed to be secondary

or indirect pathways (as indicated by parentheses) which originate from primary pathways. Many migration pathways are considered exhaustive, i.e., through a given release mechanism, the type of source would eventually be depleted. However, some potential migration pathways are thought to be moving toward a dynamic equilibrium. It should be noted that potential migration pathways are independent of exposure routes and potential receptors, i.e., a constituent may be released and migrate, but may not necessarily encounter a receptor population.

Each of the potential migration pathways listed in Table A3-1 is further discussed in Sections A3.2 (Soil Pathway) through A3.6 (Air Pathway) by environmental medium, including soils, groundwater, surface water and sediment, and air. Although technically considered a secondary source, the NAPLs are also evaluated separately, as another environmental medium. Each medium potentially receiving constituents via a migration pathway is discussed under its respective pathway (e.g., the potential release of constituents from localized subsurface soils to the uppermost aquifer via leaching is discussed under the Groundwater Pathway in Section A3.3).

A3.2 SOIL PATHWAY

The soil within the site property is characterized as the Falaya-Collins-Waverly soil association. The soils included in this association are defined as well drained to poorly drained silty soils formed in recent alluvium from the Yalobusha River and other streams (see Section 4.7 of the RI report). As presented on Table A3-1, there are three primary sources of constituents of interest in soils at the site: the on-site landfill/sludge lagoon, the former solvent storage areas (toluene and TCE), and the chromium reduction unit/equalization lagoon.

To facilitate evaluation of site soil in the baseline risk assessment, the soil data have been separated into four databases: background, interim action soils, soils under pavement, and the remainder of site soils. The "interim action soils" database represents soils collected near the on-site landfill/sludge lagoon. The "soils under pavement" database represents the former solvent storage areas. The "remainder of site soils" database contains the remaining soil samples, which are not directly related to any of the other two above primary source areas. The potential exposure concentrations for these three soil databases, interim action soils, soils under

pavement, and the remainder of site soils, are presented in the following section. Background data, which were used to evaluate the measured concentrations in soil from the other three databases to arrive at the final list of constituents of interest (see Section 5.2 of the RI report and Section A2.2), are not presented because exposure to background soils will not be evaluated. The samples associated with each of the three soil databases are identified in Attachment I, and the actual data are given in Appendix D of the RI report.

A3.2.1 Summary of Potential Exposure Concentrations

The potential exposure concentrations determined for the interim action area soils, soils under pavement, and remainder of site soils are presented in Table A3-2. As will be discussed further in Section A4.0, potential exposures to interim action soils may only be expected to occur for surficial soils (i.e., soils from 0 to 0.5 feet). For the remainder of site soils, potential exposure may be expected to occur for surficial soil (0 to 0.5 feet) and for surficial/shallow soils (i.e., soils from 0 to 8 feet). For the soils under pavement, potential exposure may only be expected to occur for the surficial/shallow soils from 0 to 8 feet (see Table A3-2).

A3.2.2 Evaluation of Potential Sources and Release Mechanisms for Soils

Soils are considered a primary medium of interest at the Randall Textron plant site. Potential release mechanisms which may result in the presence of constituents in site soils consist of three primary release mechanisms: leaching, erosion/runoff, and indirect releases (see Table A3-1). These three primary release mechanisms are discussed in the following sections.

A3.2.2.1 Potential Release of Constituents to Localized Subsurface Soils via Leaching. Many of the site constituents of interest are highly soluble compounds (see Section 6.0 of the RI report). Constituents that are highly mobile in water tend to be less strongly sorbed to soil particles and thus move more readily through soils, depending upon many factors, including the organic content of the soils. The log K_{ow} values for the volatile organics (as discussed in Sections 6.0 and 7.0 of the RI report) indicate that these constituents tend to be relatively lipophobic and may not be strongly sorbed to organic materials in soils (or biota). The generally low log K_{oc} values for the volatile constituents of interest indicate that

TABLE A3-2

SUMMARY OF POTENTIAL EXPOSURE CONCENTRATIONS FOR SOILS^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Upper 95th Percent Confidence Limit (mg/kg)			
	Interim Action Soils Surficial ^b	Soils Under Pavement Shallow ^b	Remainder of Site Soils Surficial ^b	Remainder of Site Soils Shallow ^b
Acetone	20 ^c	3	74 ^c	74 ^c
Arsenic	-- ^d	8.14	--	--
2-Butanone	ND ^e	--	ND	ND
Chloroform	ND	ND	ND	ND
Chromium (total) ^f	11,700 ^c	18.2	153	36.9
Cyanide	1.3 ^c	ND	ND	ND
1,2-Dichloroethene (total)	0.95	1.0	ND	ND
Ethyl benzene	8.7	--	ND	ND
Lead	37.8	17.6	--	--
Methylene chloride	ND	0.078	0.015 ^c	0.015 ^c
2-Methylnaphthalene	6.5 ^c	ND	ND	ND
Naphthalene	3.6 ^c	ND	ND	ND
Nickel	3,610 ^c	--	68.2	48
1,1,2,2-Tetrachloroethane	0.002	ND	ND	ND
Tetrachloroethene	0.051	--	ND	ND
Toluene	1.7	1.3	ND	ND
1,1,2-Trichloroethane	ND	ND	ND	ND
Trichloroethene	18 ^c	21	0.022 ^c	0.022 ^c
Xylene (total)	93 ^c	0.0041	ND	ND
Zinc	67.3	51.1	147	94.1

^aAll values reported in $\mu\text{g/kg}$ have been converted to mg/kg (or ppm). Upper 95th percent confidence limits (UCLs) were rounded to two significant digits for organics and three significant digits for inorganics.

^bSurficial soils are from depths of 0 to 0.5 feet. Shallow soils are from depths of 0 to 8 feet.

^cUCL exceeded maximum, therefore, the maximum detection was used as the exposure concentration (see tables in Section A2.2 for maximum detections).

^dDashes (--) indicate the constituent was not retained in the referenced database (see Section A2.2).

^eND indicates a constituent was not detected in the referenced database.

^fIn soils chromium was measured as chromium (total). Toxicity factors, however, are available for trivalent (i.e., chromium III) and hexavalent (i.e., chromium VI) chromium (see Section A5.0). Therefore, the risk associated with soils will be presented as a range assuming 100 percent chromium III and 100 percent chromium VI (see Section A6.0).

these chemicals may leach from soils. The inorganic constituents of interest tend to be much less soluble in water than organics, with a tendency to sorb to soil particles as evidenced by their soil/water partition coefficients and higher retardation factors (see Sections 6.0 and 7.0 of the RI report).

Constituents may leach from soils to subsurface soils as a result of water infiltration during incident precipitation. The constituents present in the soils associated with the landfill (i.e., the interim action area) and other site areas currently have the potential to become soluble in water through this mechanism; however, the constituents of interest in the soils associated with the former solvent storage areas are under pavement. These areas have been paved since approximately the late 1980s (See Section 2.3.1 of the RI report), after the solvent storage areas were taken out of operation. Therefore, leaching is considered significant only as a historical release mechanism for the former solvent storage areas.

The potential release of constituents to localized subsurface soil via leaching may be higher for the volatile constituents of interest than for the inorganics, but may potentially occur for both classes of constituents, and is therefore considered a potentially significant migration pathway for the Randall Textron plant.

A3.2.2.2 Potential Release of Constituents to Localized Surficial Soils via Erosion/Runoff. As noted in Table A3-1, constituents of interest in localized surficial soils may have the potential to be transported to other surficial soils via the primary release mechanism of erosion/runoff. The pattern of erosion/runoff at the Randall Textron plant is presented on Figure 4-8 of the RI report. Because the site has minimal relief and a fair amount of vegetative cover, erosional transport during runoff events does not occur to any substantial degree. Some runoff does occur on the southernmost edge of the on-site landfill, however, the concentrations of constituents in this area do not indicate substantial off site transport (see Section 7.0 of the RI report). The soils at the former toluene storage area and the former TCE storage area are under pavement and, therefore, would not be a current source of constituents to surficial soils during erosion/runoff events.

The potential release of constituents to localized surficial soils via erosion/runoff is not considered a potentially significant migration pathway for the Randall Textron plant.

A3.2.2.3 Potential Release of Constituents to Localized Subsurface Soils via Indirect Releases. Constituents of interest (primarily chromium) in association with the chromium reduction unit may have the potential to be transported into localized subsurface soils through indirect releases. As noted in Section 7.0 of the RI report, the source of the chromium groundwater plume appears to be related to the equalization lagoon and/or the chromium reduction unit, raw wastewater station, and associated process sewers. It is presumed that for groundwater to be impacted, the indirect release of constituents into subsurface soils must be occurring first. The equalization lagoon, which was built in 1961 as a holding pond for wastewaters pending treatment, is believed to be unlined and likely indirectly releasing constituents into subsurface soils (see Section 2.3.1 of the RI report). The associated components of the chromium reduction unit (e.g., wet well) may have also indirectly released constituents into the subsurface soils in the past.

Therefore, the potential release of constituents, specifically chromium, in association with the chromium reduction unit to localized subsurface soils via indirect releases is a potentially significant migration pathway at the Randall Textron plant.

A3.3 GROUNDWATER PATHWAY

There are two primary groundwater units that were investigated during the RI. The shallow unit (i.e., the uppermost aquifer) is a confined aquifer within the Basic City Shale. A confining unit (approximately 16 feet thick) of gray indurated clay shale grading downward into clay forms the base of the uppermost aquifer. The deeper unit, (i.e., the lower aquifer), is a confined aquifer, also within the Basic City Shale, which is below the base of the uppermost aquifer. The lower aquifer is underlain by another clay confining unit which is approximately 20 feet thick. Deeper water-bearing units present within the Meridian/Wilcox formation (i.e., water-bearing units below the lower aquifer) are, therefore, separated from the uppermost aquifer by two confining units. Lateral groundwater flow in the uppermost aquifer is toward the west, and discharges to Riverdale Creek and occasionally to the western portion of the outfall ditch. Vertical groundwater flow between the lower and uppermost aquifer has a net upward component due to a higher hydraulic potential in the lower aquifer (see Section 4.9.2.1 of the RI report).

A3.3.1 Summary of Potential Exposure Concentrations

The potential exposure concentrations determined for the site groundwater obtained from the uppermost aquifer are presented in Table A3-3. The samples associated with this database are identified in Attachment I, and the actual data are given in Appendix D of the RI report. As further discussed in Section A4.0, potential exposures are only expected to occur to groundwater from the uppermost aquifer.

A3.3.2 Evaluation of Potential Sources and Release Mechanisms for Groundwater

Potential release mechanisms that could lead to the presence of site constituents in groundwater that will be evaluated in the following sections include: leaching from site soils, advection and dispersion, groundwater recharge from surface water, and dissolution from LNAPL and DNAPL.

A3.3.2.1 Potential Release of Constituents from Localized Subsurface Soils to the Uppermost Groundwater Aquifer via Leaching. Volatile organic constituents generally tend to be highly soluble compounds which move readily within the soil/groundwater matrix. As discussed in Section A2.2 and Section A3.2, volatile organics were retained as constituents of interest in the surface and subsurface soils from the interim action area, and these constituents are expected to be transported through soils to the uppermost aquifer via leaching. Fifteen volatile organics were retained of interest in the groundwater from the uppermost aquifer, results which support the potential movement of volatiles from localized subsurface soils to the uppermost aquifer via leaching. The soils from the former solvent storage area are currently under pavement; therefore, leaching from localized subsurface soils to the uppermost aquifer is considered a potentially significant historical (but not present) migration pathway for this area.

Though inorganic constituents do not generally tend to become highly mobile in water, evaluation of the plume of chromium associated with the chromium reduction unit appears to indicate that subsurface soils, perhaps in direct contact with groundwater, have released chromium into the uppermost aquifer.

TABLE A3-3
SUMMARY OF POTENTIAL EXPOSURE CONCENTRATIONS
FOR GROUNDWATER^a

RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Upper 95th Percent Confidence Limits (mg/L) Groundwater in the Uppermost Aquifer
Acetone	0.44
Arsenic	0.00777 ^b
Benzene	0.58
bis(2-ethylhexyl)phthalate	0.0062
Chromium (total) ^c	3.09 ^b
Chromium III ^c	1.6377 ^d
Chromium VI ^c	1.4523 ^d
1,4-Dichlorobenzene	0.00066
1,2-Dichloroethane	0.0034
1,1-Dichloroethene	1.9
1,2-Dichloroethene (total)	160 ^e
4,4'-DDE	0.00046 ^e
Ethyl benzene	2.3
Fluorene	0.001 ^e
2-Methylnaphthalene	0.069 ^e
4-Methyl-2-pentanone	0.020
Naphthalene	0.023
Nickel	0.00945 ^b
Phenanthrene	0.0007 ^e
Phenol	0.0036
Tetrachloroethene	0.36
Toluene	71
1,2,4-Trichlorobenzene	0.0014
1,1,1-Trichloroethane	0.0041
1,1,2-Trichloroethane	0.092
Trichloroethene	690 ^e
Vinyl chloride	62 ^e
Xylene (total)	1.6 ^e

^aAll values reported in $\mu\text{g/L}$ have been converted to mg/L. Upper confidence 95th percent confidence limits (UCLs) were rounded to two significant digits for organics and three significant digits for inorganics.

^bSoluble concentrations were used for inorganics in groundwater (see Section 5.4 of the RI report).

^cBased on the use of unfiltered groundwater data, a distribution of 53 percent trivalent chromium (i.e., chromium III) and 47 percent hexavalent chromium (i.e., chromium VI) was determined (see Section A2.6). This distribution will be used in the evaluation of risk associated with chromium in groundwater.

^dThese values will be used without rounding as they represent a percent of chromium(total).

^eUCL exceeded maximum, therefore, the maximum detection was used as the exposure concentration (see Table A2-7 in Section A2.3 for maximum detections).

Therefore, the potential release of constituents from localized subsurface soils to the uppermost groundwater aquifer via leaching is considered a potentially significant migration pathway for volatile organics, and potentially significant for chromium as associated with soils near the chromium reduction unit at the Randall Textron plant.

A3.3.2.2 Potential Release of Constituents from the Uppermost Groundwater Aquifer to the Lower Aquifer via Advection and Dispersion.

As shown in Table A3-1 and as discussed above, the uppermost groundwater aquifer may have received constituents via leaching from subsurface soils. However, there is a confining clay/shale unit at the base of the uppermost aquifer which separates it from the lower aquifer. This confining clay/shale unit, in conjunction with the net upward component to groundwater flow caused by the higher hydraulic potential in the lower aquifer, precludes the movement of constituents from the uppermost aquifer to the lower aquifer via advection and dispersion (see Section 4.9.2.1 of the RI report).

Therefore, the potential release of constituents from the uppermost groundwater aquifer to the lower aquifer via advection and dispersion is not considered a significant migration pathway for the Randall Textron plant.

A3.3.2.3 Potential Release of Constituents from the Lower Aquifer to the Deeper Water-Bearing Units via Advection and Dispersion. The confining clay/shale unit between the uppermost groundwater aquifer and the lower aquifer, in conjunction with the upward component to groundwater flow from the lower aquifer, is believed to prevent the movement of constituents into the lower aquifer. The lower aquifer is in turn separated from the deeper water-bearing units by a second confining clay unit. These confining units, in conjunction with the net upward component to groundwater flow in the lower aquifer, preclude the movement of constituents from the lower aquifer to the deeper water-bearing units via advection and dispersion (see Section 4.9.2 of the RI report).

Therefore, the potential release of constituents from the lower aquifer to the deeper water-bearing units via advection and dispersion is not considered a potentially significant migration pathway for the Randall Textron plant.

A3.3.2.4 Potential Release of Constituents from Surface Water to the Uppermost Groundwater Aquifer via Groundwater Recharge. The eastern portion of the outfall ditch, the site ditches east of Route 332, the sludge lagoon, the equalization lagoon, and the swamp south of the site are all elevated above the groundwater table in the uppermost aquifer. Water in these surface water bodies appears to be perched and not in direct contact with the uppermost aquifer. This perched water, however is probably a source of recharge to the shallow groundwater (see Section 4.9.2 of the RI report). Therefore, the potential exists for the movement of constituents from surface water to groundwater via groundwater recharge (see Section 7.0 of the RI report). As noted in Section A2.4, constituents of interest in groundwater are also present in surface water collected from the eastern portion of the outfall ditch, other site ditches, sludge lagoon, and swamp.

Since the western portion of the outfall ditch and Riverdale Creek are usually not at elevations greater than the uppermost aquifer, surface water recharge to groundwater would not be expected to occur at these locations. A groundwater divide is approximately located at the eastern property boundary. Groundwater in the uppermost aquifer east of the divide flows east and ultimately discharges to the Yalobusha River (see Section 4.9.2 of the RI report). Therefore, surface water recharge from the eastern portion of the outfall ditch, ditches east of Route 332, the sludge lagoon, the equalization lagoon, and the swamp does not affect groundwater east of the groundwater divide.

Therefore, the potential release of constituents from surface water to the uppermost aquifer via groundwater recharge is considered a potentially significant migration pathway for the eastern portion of the outfall ditch, the site ditches east of Route 332, the sludge lagoon, the equalization lagoon, and the swamp area south of the site.

A.3.3.2.5 Potential Release of Constituents from LNAPL/DNAPL to the Uppermost Groundwater Aquifer via Dissolution. LNAPL, consisting primarily of toluene, is present on the surface of the uppermost groundwater in the vicinity of the former toluene storage area. DNAPL, consisting primarily of TCE, is present at the base of the uppermost aquifer, on the intermediate confining unit, in the vicinity of the former TCE storage area. The accumulations of LNAPL and DNAPL in conjunction with the flux of constituents from areas of affected soil

provide a continuing source of constituents for dissolution by passing groundwater (see Section 7.0 of the RI report).

Therefore, the potential release of constituents from LNAPL and DNAPL to the uppermost aquifer via dissolution is considered a potentially significant migration pathway.

A3.4 SURFACE WATER AND SEDIMENT PATHWAY

The surface water and sediment data collected from the Randall Textron plant have been separated into four databases to facilitate evaluation in the baseline risk assessment: downstream Riverdale Creek, background (upstream) Riverdale Creek, restricted on-site surface water and sediment (i.e., the sludge lagoon and outfall ditch west of Route 332), and the swamp and other site ditches (east of Route 332). These databases reflect the potential for access by the populations that will be evaluated for potential exposures to surface water and sediments (see Section A4.0). The samples associated with each of the four surface water and sediment databases are identified in Attachment I, and the actual data are given in Appendix D of the RI report.

A3.4.1 Summary of Potential Exposure Concentrations

The potential exposure concentrations determined for the restricted on-site surface water and sediment, the swamp and site ditches, and Riverdale Creek are presented in Tables A3-4 and A3-5. Exposures will not be evaluated for background locations.

A3.4.2 Evaluation of Potential Sources and Release Mechanisms for Surface Water and Sediment

Potential release mechanisms that could lead to the presence of site constituents in surface water and sediment that will be evaluated in the following sections include: erosion/runoff to surface water, groundwater discharge to surface water, sorption to sediments, direct releases to surface water, and downstream transport to surface water and sediment.

TABLE A3-4

SUMMARY OF POTENTIAL EXPOSURE CONCENTRATIONS FOR SURFACE WATER^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Upper 95th Percent Confidence Limit (mg/L)		
	Riverdale Creek (downstream)	Restricted On-Site ^b	Site Ditches and Swamp ^c
Acetone	0.0035	ND ^d	0.013 ^e
Aluminum	2.8 ^e	ND	-- ^f
Arsenic	0.00336	ND	ND
Barium	0.055 ^e	0.092 ^e	--
Bis(2-ethylhexyl)phthalate	0.0078 ^e	ND	--
Butyl benzyl phthalate	0.0005 ^e	ND	--
Carbon tetrachloride	ND	ND	0.0035
2-Chlorophenol	0.0004 ^e	ND	--
Chromium (total) ^g	0.407	0.681 ^e	0.0034 ^e
Chromium III ^g	0.17908 ^h	0.45627 ^h	0.002278 ^h
Chromium VI ^g	0.22792 ^h	0.22473 ^h	0.001122 ^h
Copper	0.0085 ^e	0.0090 ^e	--
1,2-Dichloroethene (total)	0.094	0.098 ^e	0.0014
Diethyl phthalate	0.0001 ^e	ND	--
Di-n-octyl phthalate	ND	0.0003 ^e	--
Iron	6.72 ^e	0.539 ^e	8.94 ^e
Lead	0.00496	0.188 ^e	0.012 ^e
Manganese	0.264 ^e	0.027 ^e	--
Methylene chloride	0.0018	ND	ND
Nickel	0.00781	0.0148	0.0157
n-Nitrosodiphenylamine	0.0004 ^e	ND	--
Pentachlorophenol	0.0005 ^e	ND	--
Toluene	0.00062	0.0020 ^e	ND
1,1,1-Trichloroethane	ND	0.00068	0.0017
Trichloroethene	0.34	0.13 ^e	0.0013
Trichlorofluoromethane	ND	ND	0.0090 ^e
Vinyl chloride	0.0054	0.0029	ND
Xylene (total)	ND	0.0014 ^e	ND
Zinc	ND	0.0138	0.0791

^aAll values reported in $\mu\text{g/L}$ have been converted to mg/L (or ppm). Upper 95th percent confidence limits (UCLs) were rounded to two significant digits for organics and three significant digits for inorganics.

^bRestricted on-site surface water includes the sludge lagoon and outfall ditch west of Route 332.

^cThe site ditches and swamp are located east of Route 332.

^dND indicates a constituent was not detected in the referenced database.

^eUCL exceeded maximum; therefore, the maximum detection was used as the exposure concentration (see tables in Section A2.4 for maximum detections).

^fDashes (--) indicate the constituent was not retained in the referenced database (see Section A2.4).

^gBased on the use of hexavalent chromium (i.e., chromium VI) data a distribution of 44 percent trivalent chromium (i.e., chromium III) and 56 percent hexavalent chromium was determined for Riverdale Creek surface water and a distribution of 67 percent trivalent and 33 percent hexavalent chromium was determined for the site ditches (see Section A2.6). These distributions will be used in the evaluation of risk associated with chromium in surface water.

^hThese values will be used without rounding as they represent a percent of chromium (total).

TABLE A3-5

SUMMARY OF POTENTIAL EXPOSURE CONCENTRATIONS FOR SEDIMENT^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Upper 95th Percent Confidence Limit (mg/kg)		
	Riverdale Creek (downstream)	Restricted On-Site ^b	Site Ditches and Swamp ^c
Acetone	ND ^d	0.036 ^e	0.068 ^e
Antimony	ND	41 ^e	-- ^f
Barium	--	1,730 ^e	--
Bis(2-ethylhexyl)phthalate	0.05 ^e	120 ^e	--
Chromium (total) ^g	31 ^e	132,000 ^e	362
Copper	--	888 ^e	--
1,2-Dichloroethene (total)	0.055 ^e	1.0 ^e	ND
Fluoranthene	ND	4.4 ^e	--
Isophorone	ND	2.4 ^e	--
Lead	11 ^e	1,350 ^e	100 ^e
Methylene chloride	0.0034 ^e	ND	ND
Nickel	13 ^e	581 ^e	--
Phenanthrene	ND	3.0 ^e	--
Tetrachloroethene	ND	1.1 ^e	ND
Trichloroethene	0.13 ^e	1.9 ^e	ND
Xylene (total)	ND	2.2 ^e	ND
Zinc	42 ^e	524 ^e	221 ^e

^aAll values reported in $\mu\text{g/kg}$ have been converted to mg/kg (or ppm). Upper 95th percent confidence limits (UCLs) were rounded to two significant digits for organics and three significant digits for inorganics.

^bRestricted on-site sediment includes the sludge lagoon and outfall ditch west of Route 332.

^cThe site ditches and swamp are located east of Route 332.

^dND indicates a constituent was not detected in the referenced database.

^eUCL exceeded maximum; therefore, the maximum detection was used as the exposure concentration (see tables in Section A2.5 for maximum detections).

^fDashes (--) indicate the constituent was not retained in the referenced database (see Section A2.5).

^gIn sediment chromium was measured as chromium (total). Toxicity factors, however, are available for trivalent (i.e., chromium III) and hexavalent (i.e., chromium VI) chromium (see Section A5.0). Therefore, the risk associated with sediments will be presented as a range assuming 100 percent chromium III and 100 percent chromium VI (see Section A6.0).

A3.4.2.1 Potential Release of Constituents to Surface Water via Erosion/Runoff. As noted in Table A3-1, constituents of interest in localized surficial soils may have the potential to be transported to surface water in Riverdale Creek, the site ditches, and the swamp through the release mechanism of erosion/runoff. The surface water drainage patterns at the Randall Textron plant are presented on Figure 4-8 of the RI report. Because the site has minimal relief and a fair amount of vegetative cover, erosional transport during runoff events would not be expected to occur to any substantial degree (see Section 7.0 of the RI report). The soils at the former solvent storage areas are currently under pavement and, therefore, could not release constituents to surface water during erosion/runoff events. Some runoff/erosion would be expected to occur on the southernmost edge of the on-site landfill. However, the concentrations of constituents in this area do not indicate substantial off site transport (see Section 7.0 of the RI report).

Therefore, the potential release of constituents to surface water via erosion/runoff is not considered a potentially significant migration pathway for the Randall Textron plant.

A3.4.2.2 Potential Release of Constituents from the Uppermost Groundwater Aquifer to Surface Water via Groundwater Discharge. The western portion of the outfall ditch and Riverdale Creek are located at elevations below the groundwater table in the uppermost aquifer (see Section 4.9.2 of the RI report). When the groundwater table is elevated with respect to the local surface water bodies, the potential exists for the movement of constituents from groundwater to surface water via groundwater discharge. As noted in Section A2.4, constituents of interest in groundwater are also present in surface water from the western portion of the outfall ditch and Riverdale Creek.

Therefore, the potential release of constituents from the uppermost aquifer to surface water in Riverdale Creek and the western portion of the outfall ditch is considered a potentially significant migration pathway.

A3.4.2.3 Potential Release of Constituents from Surface Water to Sediments via Sorption. The constituents of interest in surface water have the potential to move, through a secondary release mechanism, into sediments via sorption. Constituents which tend to sorb to soil particles (such as inorganics) would

be likely to become sorbed to sediment present in surface water bodies. Volatile organics would not tend to sorb strongly to sediments.

Therefore, the potential release of constituents from surface water to sediments via sorption is considered a potentially significant migration pathway, especially with regard to inorganic constituents.

A3.4.2.4 Potential Release of Constituents to Surface Water via Direct Release. The ditch west of Route 332 receives permitted discharges from the plant outfall associated with the wastewater treatment plant. The permit associated with this discharge contains limitations and routine monitoring requirements for several inorganic constituents, and some volatile organics have been detected in the discharge (see Section 2.3.1 of the RI report). Constituents which are present in the plant discharge (the direct release) from the outfall enter surface water in the outfall ditch.

Therefore, the potential release of constituents from the permitted discharge from the plant outfall to surface water within the outfall ditch via direct release is considered a potentially significant migration pathway.

A3.4.2.5 Potential Release of Constituents to Surface Water and Sediment via Downstream Transport. As noted in Section A3.4.2.4 above, constituents have the potential to move from the plant outfall and from groundwater discharge into the surface water present in the outfall ditch. Surface water in the outfall ditch flows west toward Riverdale Creek and enters the Creek at the confluence with the outfall ditch (see Section 2.3.1 of the RI report). Constituents present in the surface water in the outfall ditch may then be transported downstream to surface water and sediment in Riverdale Creek.

Therefore, the potential release of constituents from surface water in the outfall ditch to surface water and sediment in Riverdale Creek via downstream transport is considered a potentially significant migration pathway for the Randall Textron plant.

A3.5 NON-AQUEOUS PHASE LIQUIDS (NAPL) PATHWAY

NAPL is present at the site in the former solvent storage areas. LNAPL, consisting primarily of toluene, is floating on the groundwater surface of the uppermost aquifer in the area of the former toluene storage area. DNAPL, consisting primarily of TCE, has collected at the base of the uppermost aquifer on the intermediate confining unit in the vicinity of the former TCE storage area (see Section 7.0 of the RI report).

A3.5.1 Summary of Potential Exposure Concentrations

Potential exposure concentrations were not determined for LNAPL and DNAPL. Currently, there are no exposures to either LNAPL or DNAPL, as LNAPL is present at the surface, and DNAPL is present at the base, of the uppermost aquifer. Furthermore, LNAPL and DNAPL accumulations at the site are currently undergoing remediation through interim actions (see Section 2.6 of the RI report). Therefore, no exposures to NAPL are expected in the future.

A3.5.2 Evaluation of Potential Sources and Release Mechanisms for NAPL

NAPL is considered a secondary source or medium of interest at the Randall Textron plant. The potential release mechanism which may have resulted in the development of NAPL is the direct release of constituents from the former solvent storage areas (see Table A3-1). This release mechanism is discussed in the following section.

A3.5.2.1 Potential Release of Constituents to NAPL via Direct Release.

LNAPL, as discussed previously, consists primarily of toluene and exists on the surface of the uppermost aquifer (see Section 7.0 of the RI report). The 2,000 gallon underground storage tank (UST) of toluene present in the former toluene storage area was removed in 1988. Visual observations of the tank indicated that it appeared to be intact. Because the UST did not have any visible leaks, the most likely source of toluene LNAPL was faulty piping which may have been associated with the UST or overfill leaks/spills (see Section 2.3.1 of the RI report).

DNAPL, also as previously discussed, consists primarily of TCE and exists at the base of the uppermost aquifer (see Section 7.0 of the RI report). TCE was stored in

above ground storage tanks. The former TCE storage area includes not only the area where the tanks were located but also the associated former underground piping which transferred TCE from the tanks to the plant building. One release of TCE from the piping reportedly occurred during the 1980's. The former tanks and associated piping appear to have been the source of the DNAPL (see Section 2.3.1 of the RI report).

Therefore, the potential release of constituents, primarily toluene and TCE as NAPL, via direct releases from the former storage tanks and/or associated piping is considered a significant historical migration pathway at the Randall Textron plant.

A3.6 AIR PATHWAY

An air quality survey using an organic vapor analyzer (OVA) was conducted in the vicinity of the on-site landfill and the plant property to determine the potential for releases into air. No detectable concentrations of volatiles were measured during the air quality survey (see Sections 3.7 and 5.5 of the RI report). In addition, a soil gas survey for volatile organics was conducted to assist in delineating the boundaries of the known on-site landfill and to attempt to locate other potential VOC sources on the property. Four VOCs were analyzed including: TCE; 1,1,1-trichloroethane; 1,1,2-trichloroethane; and 1,2-dichloroethane (see Sections 3.8 and 4.4 of the RI report). The results of the soil gas survey indicated that, with the exception of one sample, all volatile detections were only TCE. These results indicate that the source of the VOCs in the soil gas is either the affected shallow soils of the on-site landfill or affected groundwater (see Section 4.4 of the RI report).

The evaluation of air will consider both volatile organics and particulate emissions. Volatilization is relevant for the soil, sediment, surface water, and groundwater databases. Particulate emission (i.e., fugitive dust emission) is relevant only for the soils present at the site, as this is the only medium which may be expected to become dry and to generate fugitive dust emissions, if disturbed.

A3.6.1 Summary of Potential Exposure Concentrations

Although useful for site characterization, data generated from surveys such as the OVA and soil gas surveys referenced above are generally not considered quantitative

enough for use in a quantitative risk assessment (USEPA, 1989a). Therefore, for soils and sediment a modeling approach was used to estimate constituent concentrations in air. This approach is presented in Attachment II, Summary of Exposure Concentrations. For surface water and groundwater, measured concentrations are converted to air concentrations through the application of a volatilization factor, "K", during the calculation of intakes (see Section A4.0).

The potential exposure concentrations modeled for the soils and sediment at the Randall Textron plant are summarized on Table A3-6.

A3.6.2 Evaluation of Potential Sources and Release Mechanisms for Air

Potential release mechanisms that could lead to the presence of site constituents in localized air that will be evaluated in the following sections include: volatilization from soils, fugitive dust emissions from soils, volatilization from surface water and sediment, and volatilization from groundwater.

A3.6.2.1 Potential Release of Constituents from Soils to Localized Air via Volatilization. Many of the constituents of interest in soils are highly volatile compounds, as is evidenced by their vapor pressures (see Section 6.0 of the RI report and Table A3-2). However, as noted in Section A3.6, there were no detectable concentrations of volatiles measured during the air quality survey of the site, indicating that there are no current emissions of volatiles occurring at the site and the soil gas survey indicated only that TCE was present near the landfill. In addition, there is a fair amount of vegetative cover present at the site associated with the interim action area (i.e., soils associated with the on-site landfill) and the remainder of site soils. The presence of such vegetative cover lessens the potential for volatilization. The soils associated with the former solvent storage area are under pavement. These areas have been paved since approximately the late 1980's (see Section 2.3.1 of the RI report) after the solvent storage areas were in operation. Therefore, no volatilization is expected to occur from the soils under pavement. Inorganic constituents of interest in the soils are not expected to volatilize readily, if at all (see Section 6.0 of the RI report). If the site is disturbed in some fashion, such as through the removal of the vegetative cover or of the pavement covering the soils in the former solvent storage area, the volatilization of constituents from soils may be expected to occur.

TABLE A3-6

SUMMARY OF POTENTIAL EXPOSURE CONCENTRATIONS IN AIR^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Upper 95th Percent Confidence Limit (mg/m ³)				Upper 95th Percent Confidence Limit (mg/m ³)			
	Interim Action Soils Surface ^b Maintenance	Soils Under Pavement Shallow ^b Construction	Remainder of Site Soils Surface ^b Maintenance	Remainder of Site Soils Shallow ^b Construction	Remainder of Site Soil Surface ^b Recreational/ Trespasser	Remainder of Site Soil Surface ^b Residential	Restricted On-Site Sediment ^c Maintenance	Site Ditches and Swamp Sediment ^d Maintenance
Acetone	0.17 ^e	0.025	1.5 ^e	2.3 ^e	1.9 ^e	0.67 ^e	0.00017 ^e	0.00071 ^e
Antimony	-- ^f	--	--	--	--	--	NA ^g	--
Arsenic	--	3.3x10 ⁻⁹	--	--	--	--	--	--
Barium	--	--	--	--	--	--	NA	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	NA	--
2-Butanone	ND ^h	--	ND	ND	ND	ND	--	--
Chloroform	ND	ND	ND	ND	ND	ND	--	--
Chromium (total) ⁱ	NA	7.4x10 ⁻⁹	1.7x10 ⁻⁷	4.1x10 ⁻⁸	1.7x10 ⁻⁷	1.7x10 ⁻⁷	NA	NA
Copper	--	--	--	--	--	--	NA	--
Cyanide	NA	ND	ND	ND	ND	ND	--	--
1,2-Dichloroethene (total)	0.0079	0.0083	ND	ND	ND	ND	0.0045 ^e	ND
Ethyl benzene	0.051	--	ND	ND	ND	ND	--	--
Fluoranthene	--	--	--	--	--	--	NA	--
Isophorone	--	--	--	--	--	--	NA	--
Lead	NA	7.2x10 ⁻⁹	--	--	--	--	NA	--
Methylene chloride	ND	0.0010	0.00047 ^e	0.00075 ^e	0.00063 ^e	0.00023	ND	NA
2-Methylnaphthalene	NA	ND	ND	ND	ND	ND	--	ND
Naphthalene	0.0021 ^e	ND	ND	ND	ND	ND	--	--
Nickel	NA	--	7.5x10 ⁻⁸	5.3x10 ⁻⁸	7.5x10 ⁻⁸	7.5x10 ⁻⁸	NA	--
Phenanthrene	--	--	--	--	--	--	9.1x10 ^{-5e}	--
1,1,2,2-Tetrachloroethane	4.2x10 ⁻⁶	ND	ND	ND	ND	ND	--	--
Tetrachloroethene	0.0003	--	ND	ND	ND	ND	0.0037 ^e	ND
Toluene	0.017	0.013	ND	ND	ND	ND	--	--
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	--	--

TABLE A3-6 (Continued)

SUMMARY OF POTENTIAL EXPOSURE CONCENTRATIONS IN AIR^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	Upper 95th Percent Confidence Limit (mg/m ³)				Upper 95th Percent Confidence Limit (mg/m ³)			
	Interim Action Soils Surficial ^b Maintenance	Soils Under Pavement Shallow ^b Construction	Remainder of Site Soils Surficial ^b Maintenance	Remainder of Site Soils Shallow ^b Construction	Remainder of Site Soil Surficial/ Recreational/ Trespasser	Remainder of Site Soil Surficial Residential	Restricted On- Site Sediment ^c Maintenance	Site Ditches and Swamp Sediment ^d Maintenance
Trichloroethene	0.16 ^e	0.18	0.00044 ^e	0.00071	0.00058	0.00022	0.0095 ^e	ND
Xylene (total)	0.42 ^e	1.8x10 ⁻⁵	ND	ND	ND	ND	0.0054 ^e	ND
Zinc	NA	2.1x10 ⁻⁸	1.6x10 ⁻⁷	1.0x10 ⁻⁷	1.6x10 ⁻⁷	1.6x10 ⁻⁷	NA	NA

^aThe estimation of air concentrations based on soil concentrations is presented in Attachment II. Upper confidence limits (UCLs) were rounded to two significant digits for organics and inorganics.

^bAir concentrations based on surficial soils are determined from soil samples from depths of 0 to 0.5 feet; those based on shallow soils are determined from soil samples from depths of 0 to 8 feet.

^cRestricted on-site sediment includes the sludge lagoon and outfall ditch west of Route 332.

^dThe site ditches and swamp are located east of Route 332.

^eUCL exceeded maximum; therefore, the maximum detection was used to calculate the exposure concentration in air (see tables in Section A2.2 and Attachment II).

^fDashes (--) indicate the constituent was not retained in the referenced data base (see Section A2.2).

^gNA indicates that an air concentration could not be calculated for a constituent because the volatilization factor (VF) and/or the particulate emission factor (PEF) could not be calculated.

^hND indicates a constituent was not detected in the referenced data base.

ⁱIn soils and sediment chromium was measured as chromium (total). Toxicity factors, however, are available for trivalent (i.e., chromium III) and hexavalent (i.e., chromium VI) chromium (see Section A5.0). Therefore, the risk associated with soils and sediment will be presented as a range assuming 100 percent chromium III and 100 percent chromium VI (see Section A6.0).

Therefore, under current site conditions, the potential release of constituents from soils to localized air via volatilization is not considered a potentially significant migration pathway. If the soils become disturbed in the future, the migration pathway may become significant.

A3.6.2.2 Potential Release of Constituents from Soils to Localized Air via Fugitive Dust Emissions. Several of the constituents retained of interest in soils, (i.e., the inorganic constituents arsenic, chromium, cyanide, lead, nickel, and zinc), are constituents which are not easily volatilized, but that may be released via fugitive dust emissions. The presence of a fair amount of vegetative cover at the site lessens the potential for fugitive dust emissions. In addition, the soils associated with the former solvent storage area are under pavement. If the site is disturbed in some fashion such as through the removal of the vegetative cover or removal of the pavement covering the soils in the former solvent storage area, the release of constituents from soils via fugitive dust emission may be expected to occur.

Therefore, under current site conditions, the potential release of constituents from soils to localized air via fugitive dust emissions is not considered a potentially significant migration pathway. In the future, if the site is disturbed, this may become a significant migration pathway for inorganic constituents.

A3.6.2.3 Potential Release of Constituents from Surface Water to Localized Air via Volatilization. Several of the constituents retained of interest in surface water at the site are volatile organics, many of which are highly volatile compounds (see Section 6.0 of the RI report). Volatile organics were detected in each of the surface water bodies of interest (Riverdale Creek, site ditches and swamp, and restricted on-site surface water) (see Table A3-4). The potential exists for these constituents to volatilize into localized air.

Therefore, the potential release of constituents from surface water to localized air via volatilization is considered a potentially significant migration pathway for

volatile organics in surface water from the Riverdale Creek, site ditches and swamp, and restricted on-site surface water locations at the Randall Textron plant.

A3.6.2.4 Potential Release of Constituents from Sediment to Localized Air via Volatilization. Several of the constituents retained of interest in sediment at the site are organics, many of which are highly volatile compounds (see Section 6.0 of the RI report). Limited volatile organics were detected in the sediment from Riverdale Creek, in the sediment from the site ditches and swamp, and in the restricted on-site sediment locations (see Table A3-5). Although volatilization would not be expected to be occurring under current site conditions, disturbance of the sediments associated with these area in the future may result in the volatilization of the organic compounds.

Therefore, under current site conditions, the potential release of constituents from sediment to localized air via volatilization is not considered a potentially significant migration pathway. However, if the sediments from Riverdale Creek, the site ditches and swamp, or from the restricted on-site sediment locations are disturbed in the future, volatilization could occur.

A3.6.2.5 Potential Release of Constituents from Groundwater to Localized Air via Volatilization. Most of the constituents of interest in groundwater are volatile organics, many of which are highly volatile compounds (see Section 6.0 of the RI report). Under current site conditions, groundwater at the site is not exposed to the atmosphere and there are no human receptors utilizing the uppermost aquifer as a source of groundwater. Therefore, there is no mechanism by which volatilization to localized air could occur. In the future, if human receptors utilize the uppermost aquifer as a source of water for household or other usages, then volatilization could occur upon exposure of groundwater to air, e.g., through the process of showering.

Therefore, under current site conditions, the potential release of constituents from groundwater to localized air via volatilization is not considered a potentially significant migration pathway. If the uppermost aquifer is utilized as a domestic water supply in the future, then this migration pathway may become significant.

A3.7 IDENTIFICATION OF POTENTIAL RECEPTORS AND CURRENT AND FUTURE EXPOSURE SCENARIOS

In the following section, current and potential future land use are described in order to evaluate potential human receptors which may be exposed to site constituents. Land use and demography information pertinent to the Randall Textron plant are presented in Section 4.10 of the RI report. The potential current and future receptor populations and expected exposure routes are generally discussed below, by medium. The quantification of potential relevant exposure routes and the discussion of specific exposure parameters for each potential receptor population will be given in Section A4.0.

Current Scenario. The Randall Textron plant is located just outside the corporate limits of the city of Grenada. The facility is active, and is involved in the manufacture of automobile wheel covers.

Site access is generally limited due to a chainlink fence with barbed wire, and the presence of a 24 hour security guard. Although some portions of the Randall Textron plant site are outside of the fence, the on-site landfill and outfall ditch east of Route 332 are within the fence area. Grenada County has no defined zoning regulations for areas outside the city limits. The land use in the vicinity of the site is primarily rural and residential.

Marsh land or swamp is located south and west of the former Rockwell facility. There is one residence located at the edge of this marshy area, approximately 1/4 mile southwest of the property boundary. There are no other residences south or west within a 1/2 mile radius of the site. The area that is south of the site has been incorporated and is zoned for heavy industry (I-2), but has not been developed (see Figure 4-22 of the RI report). The plant site is approximately one mile from the northernmost section of the city of Grenada that has been zoned residential (see Section 4.10 of the RI report).

The Illinois Central Gulf Railroad borders the site to the north and east. Eastern Heights Subdivision is located directly across the railroad tracks north of the facility. Several residences are within a few hundred feet of the site, and the entire

subdivision is within 1/4 mile of the northern boundary of the site (see Section 4.10 of the RI report).

Impacted groundwater is believed to have migrated off site only in the area west of the landfill near Riverdale Creek (groundwater flows west toward the Creek). There are no known private wells located in this area.

Currently, the potential human receptor populations associated with the site are expected to include occupational maintenance workers on site and possibly a recreational/trespasser population who may access Riverdale Creek.

Future Scenarios. There are no known plans to change plant operations in any way in the future. The only known current activities which may result in any changes in the site in the future are the implementation of Interim Action remedial activities (see Section 2.6 of the RI report), and the closure of the equalization lagoon per RCRA requirements (see Section 2.3.1.2 of the RI report). No plans for building or expansion are currently known to exist. However, it is possible that in the future, plant operations may be phased out and the site become inactive, or the site could be used for other industrial purposes, further developed, or renovated. Therefore four future site scenarios were considered: (1) conditions remain essentially the same as the current situation (i.e., the plant remains active); (2) the site becomes inactive; (3) the site undergoes residential development; and (4) the site undergoes industrial development. If in the future residential development occurs, a new residential population would be relevant.

If in the future the Randall Textron plant continues to operate, then future conditions and potential receptors associated with the site under this scenario would be expected to be the same as the current land use scenario. If the plant ceases to operate in the future, the site may become essentially inactive, there would likely not be any occupational workers (including maintenance workers) associated with the site, and the recreational/trespasser population would be expected to be the same as the current situation, except that this population may be able to access more portions of the site, due to the lessening of site security.

Currently, much of the main site is either covered with pavement or facility buildings. In addition, the area south of the site, which is within the city limits, is

zoned for heavy industrial usage. For these reasons, it is not considered likely that residences would be present on site in the future. However, because there are no zoning restrictions outside of the Grenada city limits, potential future residential development in the area of the site is possible. Furthermore, though a public water supply is available for rural residences, there is no restriction on the installation of private wells. In addition, the Grenada County Board of Health does not approve wells after installation. Therefore, even though residential development of the site is not believed likely in the future, there is nothing to prevent a potential off-site resident from installing a groundwater well in the uppermost aquifer, including the area of impacted groundwater. It should be noted that the uppermost aquifer has poor pumping capacity, while the deeper aquifers are more prolific. However, the well survey (see Section 4.9.1.4 of the RI report) indicated that there are some wells in the area that may be located in the uppermost aquifer, though the majority are located in the deeper aquifers. If future residential development does occur, it is possible that a construction worker population would be relevant.

If site development occurs in the future, it is more likely that it will involve some type of construction activity for industrial usage, or some type of renovation. Therefore, under the future site industrial development scenario, the existence of a construction worker population is possible.

A3.7.1 Soil Pathway

The populations which may reasonably be exposed to soils at the Randall Textron plant are discussed in the following sections. As previously discussed, soils associated with the site have been divided into the following groups: interim action area; soils under pavement; background (which will not be evaluated); and remainder of site soils.

A3.7.1.1 Current Populations

Occupational Populations. Currently, the only occupational population believed to be present at the Randall Textron plant which could potentially be exposed to constituents present in soils is the maintenance worker. Maintenance workers may be expected to be potentially exposed to surficial soils from the restricted access areas (e.g., the landfill and interim action area), as well as the remainder of site

soils area during the course of normal maintenance activities. Exposure would only be expected to occur from contact with surficial soils (i.e., soils from a depth of 0 to 0.5 feet) through activities such as lawn maintenance and mowing, picking up litter, etc. No exposure to a maintenance worker would be expected to occur from soils under pavement, as these soils would not be accessible when engaged in these types of activities. Exposure routes potentially associated with the occupational maintenance worker may include: incidental ingestion, dermal contact, and inhalation of vapors and particulates for surficial soils.

Recreational/Trespasser Populations. A recreational/trespasser population is not expected to access the interim action area, the main site, or the soils under pavement under current conditions. Access to these areas is restricted by a fence, and a 24-hour security guard is present at the main plant site.

Residential Populations. Currently, there are no residential populations associated with any soils on the Randall Textron plant site.

A3.7.1.2 Potential Future Populations. Although a number of future site scenarios are possible, potential future receptor populations are discussed collectively below.

Occupational Populations. An additional occupational population evaluated under the future site development scenarios (residential or industrial) is a construction worker population. It is expected that construction worker activity could take place near the former solvent storage areas (the soils under pavement area), as well as in the area of the remainder of site soils. There would be no exposure expected from the interim action area soils, as this area will be remediated in the immediate future. It is expected that a construction worker population could be exposed to surficial and shallow soils from 0 to 8 feet (collectively) by activities associated with excavation, building, etc. Anticipated exposure routes would include incidental ingestion, dermal contact, and inhalation of vapor and particulates.

Recreational/Trespasser Populations. Under the future scenario where the site may become inactive, it is possible that security of the site will decrease, allowing for the potential access of a recreational/trespasser population to unrestricted area of the site (i.e., remainder of site soils). This population may be engaged in activities

such as hiking, walking, hunting, or playing at or near the site. Exposure routes that will be evaluated include incidental ingestion, dermal contact with, and inhalation of vapors and particulates from remainder of site surficial soils (0 to 0.5 feet). Exposure to subsurface soils would not be expected during these types of activities. Furthermore, the potential recreational/trespasser population would not be expected to contact soils under pavement, and the interim action area soils will be remediated in the immediate future.

Residential Populations. As there are no zoning restrictions outside the Grenada City limits, a future residential site development scenario cannot be eliminated. Under such a future site development scenario, it is expected that a residential population could come into contact with soil outside the residence while working or playing. It is expected that contact would only occur with surficial soil (0 to 0.5 feet) from the remainder of the site. This residential population will be evaluated for potential exposures through incidental ingestion, dermal contact, and inhalation of vapors and particulates. The potential residential population would not be expected to contact subsurface soil, or soils under pavement, and the interim action area soils will be remediated in the immediate future.

A3.7.2 Groundwater Pathway

The populations which may reasonably be exposed to groundwater from the uppermost aquifer near the Randall Textron plant are discussed in the following sections.

A3.7.2.1 Current Populations. The shallow groundwater aquifer (i.e., the uppermost aquifer), has been demonstrated during the RI (see Section 5.4.2 of the RI report) to be impacted by site constituents in the area west of the landfill, near Riverdale Creek. There are no wells currently located in this area where impacted groundwater is thought to be migrating off site. The wells which supply water for Randall Textron plant operations are installed in the Meridian/Wilcox aquifer, and are separated from the uppermost aquifer by two confining clay units. Therefore, there are no current occupational, residential, or recreational exposures to groundwater believed to currently exist.

A3.7.2.2 Potential Future Populations

Occupational Populations. There are no occupational populations which would be expected to contact impacted site groundwater from the uppermost aquifer, as the plant wells pump water from the deeper water-bearing units which are unimpacted and separated from the uppermost aquifer by two confining clay units.

Recreational Populations. There are no recreational populations which would be expected to contact groundwater from the uppermost aquifer due to lack of a point of contact.

Residential Populations. As previously discussed, although public water is available for rural residences, there are no restrictions on the installation of private wells. In addition, the Grenada County Board of Health does not have to approve wells after installation (see Section 4.9.1.4 of the RI report). Therefore, under the future site development scenario, it is possible that a future resident could install a groundwater well in the uppermost aquifer, potentially in an area that would receive impacted groundwater. Although the uppermost aquifer has poor yield, the well survey conducted during the RI (see Section 4.9.1.4 of the RI report) indicated that there are some wells in the local area that may be installed in the uppermost aquifer. Therefore, under the future site residential development scenario, potential groundwater exposure to a residential population by use of groundwater as a potable water source will be evaluated. Potential exposure routes that will be evaluated for the residential population include ingestion, dermal contact, and inhalation of vapors (while showering).

A3.7.3 Surface Water and Sediment Pathway

There are three surface water bodies associated with the Randall Textron plant: downstream Riverdale Creek (not including background locations); restricted on-site surface water (the outfall ditch and sludge lagoon); and the site ditches and swamp.

A.3.7.3.1 Current Populations.

Occupational Populations. Currently, the only occupational population associated with the site would be a maintenance worker population which may

contact surface water and sediment in the restricted on-site water bodies, or in the ditches and swamp while engaged in activities such as maintenance of site ditches, work associated with the outfall ditch and lagoon, or pest control. The only exposure route which would be expected to be relevant to this population would be dermal contact with surface water and sediments, and inhalation of vapors from surface water and sediment (inhalation of particulates is not expected to be significant because it is assumed that these water bodies will be continually wet, and dust generation will be minimal). No potential exposures for the maintenance worker population to Riverdale Creek are expected.

Recreational Populations. Currently, it is possible that a recreational/trespasser population may access surface water and sediment in downstream Riverdale Creek while wading, walking, or other recreational activities. Minimal contact with creek sediments would be expected with these activities. Exposure routes which would be expected to be relevant to this population include incidental ingestion of surface water; dermal contact with surface water and sediment; and inhalation of vapors from surface water. It was assumed that inhalation of particulates would not be significant because Riverdale Creek sediments would be expected to be continually wet. It is anticipated that the restricted on-site surface water bodies, as well as the site ditches and swamp would not currently be relevant to this population due to limited site access.

Residential Populations. Currently, there are no residential populations which would be expected to contact surface water or sediment associated with the Randall Textron plant site.

A3.7.3.2 Potential Future Populations

Occupational Populations. There are no additional occupational populations in the future which are expected to be relevant to surface water and sediment associated with the Randall Textron plant site.

Recreational Populations. Under the potential future scenario of the plant becoming inactive, it is possible that a recreational/trespasser population could contact surface water and sediment from the restricted on-site water bodies, as well as from the swamp and site ditches, due to the potential lessening of site security.

This population may be engaged in activities such as wading the ditches or hunting in the swamp. Minimal contact with sediment would be expected with these activities. Exposure routes which would be expected to be relevant include incidental ingestion of surface water; dermal contact with surface water and sediment; and inhalation of vapors from surface water. It was assumed that inhalation of particulates would not be significant because sediments would be wet more often than dry.

Residential Populations. There are no residential populations anticipated to be associated with surface water and sediments in the future, or if present, this population would be represented by recreational exposures.

A4.0 QUANTIFICATION OF POTENTIAL EXPOSURES

In Section A3.0, potential sources and release mechanisms (i.e., migration pathways) were evaluated, and potential receptors and likely exposure scenarios and exposure routes were identified. In this section, potential exposures identified in Section A3.0 as having the highest likelihood of occurrence (and for which sufficient data are available to evaluate fully) are quantified. According to the latest available federal risk assessment guidance (USEPA, 1989a), actions at Superfund sites should be based on an estimate of the "reasonable maximum exposure" (RME) expected to occur under both current and future land use conditions. The "reasonable maximum exposure" is defined in the federal guidance as "the highest exposure that is reasonably expected to occur at a site." RMEs are estimated for individual exposure routes, and if a population is potentially exposed via more than one pathway, the combination of exposures across pathways also must represent an RME. As would be expected, especially for the determination of intakes involving potential future exposures, estimates of the "reasonable maximum exposure" necessarily involve the use of professional judgment (USEPA, 1989a).

In the past, exposures which were quantified during the baseline risk assessment generally were estimated for an average and an upper-bound exposure case, instead of a single exposure case (for both current and future land use). However, in the current federal risk assessment guidance (USEPA, 1989a), USEPA recommends the use of the RME approach in which one number is generated (i.e., an upper 95th percent confidence limit), rather than a range of numbers. According to this guidance document, the disadvantage of the two-case approach (i.e., average and upper bound) is that the upper-bound estimate of exposure may be above the range of possible exposures, whereas the average estimate may be lower than exposures potentially experienced by much of the population. The intent of using the RME approach in the current guidance is to estimate a conservative exposure case (i.e., well above the average case) that is still within the range of possible exposures (USEPA, 1989a). For each potentially exposed population, and for each relevant route of exposure, chemical-specific estimates of the magnitude, frequency, and duration of potential exposures are determined.

The quantification of potential exposures is conducted in two parts (USEPA, 1989a): (1) the estimation of exposure concentrations in various environmental media which

are expected to be contacted over the exposure period; and (2) the calculation of "intakes" or normalized exposure estimates which describe the mass of a constituent expected to be in a contact with the human body per unit body weight, per unit time (e.g., in units of mg/kg-day). The 95th percent upper confidence limit on the arithmetic averages of site constituents in various environmental media of relevance to the exposure assessment were presented and described in detail in Section A3.0 (see the "Summary of Potential Exposure Concentrations" sections), and are utilized, as appropriate, in the execution of the quantification step.

Chemical-specific intakes are generally calculated using equations which may include variables such as: exposure concentration, contact rate, exposure frequency, exposure duration, body weight, and exposure averaging time. Other variables specific to a particular exposure route may also be included in the intake equations. The values used for some of the variables in the intake equations are determined on a site-specific basis in order to accurately reflect the relevant site conditions and characteristics of a given potentially exposed populations. Values used for other variables may be based on: conservative assumptions; "standard" values typically used in the risk assessment process (e.g., adult body weight of 70 kg); or other sources of information. Once intakes have been estimated for the relevant potentially exposed populations they will be used later in the Risk Characterization (see Section A6.0), along with relevant toxicity values generated during the Toxicity Assessment (see Section A5.0), to estimate potential risks posed by the site under baseline conditions. Because the concentrations of constituents in site media have already been discussed in detail in Sections A2.0 and A3.0, the concentrations of site constituents will not be further discussed. The remainder of this section will focus on the determination of intakes for the potential exposure routes which are identified for quantification.

A.4.1 SUMMARY OF POTENTIAL EXPOSURE ROUTES TO BE QUANTIFIED

The identification of potential receptors and likely exposure scenarios for the project site was previously discussed in detail in Section A3.7. These potential receptors and exposure routes are summarized, by medium, in Table A4-1 (soil), Table A4-2 (groundwater), and Table A4-3 (surface water and sediment), for both potential current and future exposure scenarios.

TABLE A4-1

**SUMMARY OF POTENTIAL CURRENT AND FUTURE EXPOSURE ROUTES
FOR SOILS**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Area and Scenario (Current or Future)	Receptor Population	Exposure Route	Depth of Soil Contacted
<u>I. Interim Action Area</u>			
1. Current (and Future No Action)	Occupational Maintenance Worker	Dermal Contact	Surficial Soils (0-0.5 feet)
2. Current (and Future No Action)	Occupational Maintenance Worker	Incidental Ingestion	Surficial Soils (0-0.5 feet)
3. Current (and Future No Action)	Occupational Maintenance Worker	Inhalation of Vapors and Particulates	Surficial Soils (0-0.5 feet)
<u>II. Soils Under Pavement</u>			
1. Future Site Development (Only)	Occupational Construction Worker	Dermal Contact	Surficial and Shallow Soils (0-8 feet)
2. Future Site Development (Only)	Occupational Construction Worker	Incidental Ingestion	Surficial and Shallow Soils (0-8 feet)
3. Future Site Development (Only)	Occupational Construction Worker	Inhalation of Vapors and Particulates	Surficial and Shallow Soils (0-8 feet)
<u>III. Remainder of Site Soils</u>			
1. Current (and Future No Action)	Occupational Maintenance Worker	Dermal Contact	Surficial Soils (0-0.5 feet)
2. Current (and Future No Action)	Occupational Maintenance Worker	Incidental Ingestion	Surficial Soils (0-0.5 feet)
3. Current (and Future No Action)	Occupational Maintenance Worker	Inhalation of Vapors and Particulates	Surficial Soils (0-0.5 feet)

TABLE A4-1 (Continued)**SUMMARY OF POTENTIAL CURRENT AND FUTURE EXPOSURE ROUTES
FOR SOILS****RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Area and Scenario (Current or Future)	Receptor Population	Exposure Route	Depth of Soil Contacted
<u>III. Remainder of Site Soils (Cont.)</u>			
4. Future Site Development and Future Inactive	Recreational/ Trespasser	Dermal Contact	Surficial Soils (0-0.5 feet)
5. Future Site Development and Future Inactive	Recreational/ Trespasser	Incidental Ingestion	Surficial Soils (0-0.5 feet)
6. Future Site Development and Future Inactive	Recreational/ Trespasser	Inhalation of Vapors and Particulates	Surficial Soils (0-0.5 feet)
7. Future Site Development (Only)	Occupational Construction Worker	Dermal Contact	Surficial and Shallow Soils (0-8 feet)
8. Future Site Development (Only)	Occupational Construction Worker	Incidental Ingestion	Surficial and Shallow Soils (0-8 feet)
9. Future Site Development (Only)	Occupational Construction Worker	Inhalation of Vapors and Particulates	Surficial and Shallow Soils (0-8 feet)
10. Future Site Development (Only)	Residential	Dermal Contact	Surficial Soils (0-0.5 feet)
11. Future Site Development (Only)	Residential	Incidental Ingestion	Surficial Soils (0-0.5 feet)
12. Future Site Development (Only)	Residential	Inhalation of Vapors and Particulates	Surficial Soils (0-0.5 feet)

TABLE A4-2

**SUMMARY OF POTENTIAL FUTURE EXPOSURE ROUTES FOR
UPPERMOST GROUNDWATER**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Scenario (Current or Future)	Receptor Population	Exposure Route
Future Site Development (Only)	Residential	Dermal Contact
Future Site Development (Only)	Residential	Incidental Ingestion
Future Site Development (Only)	Residential	Inhalation of Vapors

TABLE A4-3

**SUMMARY OF POTENTIAL CURRENT AND FUTURE EXPOSURE ROUTES
FOR SURFACE WATER AND SEDIMENT**

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Water Body and Scenario (Current or Future)	Receptor Population	Exposure Route	Medium
<u>I. Riverdale Creek (Downstream)</u>			
1. Current (and Future No Action)	Recreational/Trespasser	Dermal Contact	Surface Water
2. Current (and Future No Action)	Recreational/Trespasser	Incidental Ingestion	Surface Water
3. Current (and Future No Action)	Recreational/Trespasser	Inhalation of Vapors	Surface Water
4. Current (and Future No Action)	Recreational/Trespasser	Dermal Contact	Sediment
<u>II. Restricted Onsite</u>			
1. Future Inactive (Only)	Recreational/Trespasser	Dermal Contact	Surface Water
2. Future Inactive (Only)	Recreational/Trespasser	Incidental Ingestion	Surface Water
3. Future Inactive (Only)	Recreational/Trespasser	Inhalation of Vapors	Surface Water
4. Future Inactive (Only)	Recreational/Trespasser	Dermal Contact	Sediment
5. Current (and Future No Action)	Occupational Maintenance Worker	Dermal Contact	Surface Water
6. Current (and Future No Action)	Occupational Maintenance Worker	Inhalation of Vapors	Surface Water
7. Current (and Future No Action)	Occupational Maintenance Worker	Dermal Contact	Sediment
8. Current (and Future No Action)	Occupational Maintenance Worker	Inhalation of Vapors	Sediment

TABLE A4-3 (Continued)**SUMMARY OF POTENTIAL CURRENT AND FUTURE EXPOSURE ROUTES
FOR SURFACE WATER AND SEDIMENT****RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

Water Body and Scenario (Current or Future)	Receptor Population	Exposure Route	Medium
<u>III. Ditches and Swamp</u>			
1. Future Site Development and Future Inactive	Recreational/Trespasser	Dermal Contact	Surface Water
2. Future Site Development and Future Inactive	Recreational/Trespasser	Incidental Ingestion	Surface Water
3. Future Site Development and Future Inactive	Recreational/Trespasser	Inhalation of Vapors	Surface Water
4. Future Site Development and Future Inactive	Recreational/Trespasser	Dermal Contact	Sediment
5. Current (And Future No Action)	Occupational Maintenance Worker	Dermal Contact	Surface Water
6. Current (And Future No Action)	Occupational Maintenance Worker	Inhalation of Vapors	Surface Water
7. Current (And Future No Action)	Occupational Maintenance Worker	Dermal Contact	Sediment
8. Current (And Future No Action)	Occupational Maintenance Worker	Inhalation of Vapors	Sediment

Four different potential human receptor populations were evaluated: the recreational/trespasser; the occupational maintenance worker; the occupational construction worker; and the residential populations. Two of these four populations were assumed to consist only of adults (the occupational maintenance and construction workers), and two populations were considered to include adults and children (recreational/trespasser and residential) (see Section 3.7). With respect to the recreational/trespasser population, it was believed that children would represent part of the population, however, to access the media evaluated, either an active railroad line or Route 332 would need to be crossed and fences would typically need to be climbed. Therefore, it was not believed reasonable to assume that a 1 to 6 year old would be included in the recreational/trespasser population. For the Randall Textron plant, therefore, the child exposure population is evaluated from ages 7 to 18 years old (a 12 year duration). The recreational/trespasser adult is evaluated from ages 19 to 36 years old (an 18 year duration) to result in the USEPA's default recreational exposure duration of 30 years (USEPA, 1991a).

The USEPA also recommends a 30 year exposure duration for the residential exposure scenario. As noted in USEPA's directive entitled "Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors" (Standard Default Exposure Factors; USEPA, 1991a) (specifically for the incidental ingestion of soil pathway), the residential exposure is divided into two parts. The first part evaluates a 6 year exposure duration for young children which accounts for the highest soil ingestion rate and the lowest body weight. The second part evaluates a 24-year exposure duration for older children and adults and uses a lower ingestion rate (for soil) and an adult body weight (USEPA, 1991a). This convention, i.e., a child evaluated from 1 to 6 years and an "adult" evaluated for 24 years (or 7 to 30 years of age) has been retained for all residential exposure scenarios. USEPA recommends a standard default occupational duration of 25 years (USEPA, 1991a).

As previously discussed, besides the current scenario, four possible scenarios may exist in the future. These include: 1) no change from the current situation (or no action); 2) the plant ceases to operate and the site becomes inactive; 3) future residential development; and 4) future industrial development. Depending upon which, if any, of these future scenarios take place, different exposures may be expected. The anticipated additional exposure routes associated with each of these

four potential future exposure scenarios are identified in Tables A4-1 through A4-3. Therefore, the following number of exposure routes (current and future) will be quantified: soil, 18; groundwater, 3; surface water, 13; and sediment, 7, for a total of 41 individual exposure routes.

As discussed in Section A3.7, for the recreational/trespasser, maintenance worker, and residential populations, potential exposures with soils were assumed to be limited to constituents potentially present in surficial soils. However, for the construction worker population, potential exposures to constituents in surficial and subsurface soils were assumed to occur over the 0 to 8 foot depth interval. Furthermore, it was assumed that under the current scenario, the recreational/trespasser population would only potentially come in contact with surface water and sediment from downstream Riverdale Creek, whereas the occupational maintenance worker would not come in contact with Riverdale Creek, but may contact restricted on-site water bodies, other site ditches, and the swamp. Also, as discussed in Section A3.7, it was assumed that in the future, the recreational/trespasser population may contact the on-site water bodies as well, and that only the potential future residential population would come in contact with groundwater.

Concentrations of site constituents expected to be found in media of interest at the site in the future were conservatively assumed to be the same as the concentrations currently observed in site media. Also, it was assumed that, if no site development activities occur in the future, then any current activities and use scenarios can be assumed to be also relevant for the future. If development (or inactivity) of the site were to occur, each of the exposure routes relevant for the current (and future no action) scenarios listed above, may also be relevant under the future site scenarios.

As discussed in Section A3.7, it was also assumed that residential development may occur in the vicinity of the site in the future. Although the continued presence of the recreational populations would be expected under future site development scenarios, the frequency of exposure is not expected to change. Therefore, the intake estimates for these populations will be the same under the future site development scenarios as under the current (and future no action) scenarios.

Although the likelihood of these exposure scenarios occurring on a chronic, daily basis is remote, it is believed that the potential exposure routes to the populations listed above represent the most reasonable maximum exposures expected to be presented by the Randall Textron plant site for which there are sufficient data to make their quantification meaningful.

A4.2 ESTIMATION OF INTAKES

The 41 different exposure scenarios listed in Tables A4-1, A4-2, and A4-3 collectively involve only six basic human exposure routes. These six exposure routes are:

- Dermal contact with soil or sediment
- Incidental ingestion of soil or sediment
- Inhalation of vapors and/or particulates in air from soil or sediment
- Dermal contact with water
- Incidental ingestion of water
- Inhalation of vapors from water

Intakes for each of the exposure routes will be estimated by use of the intake equations given in the current federal risk assessment guidance (USEPA, 1989a). The general intake equations are presented in Table A4-4.

An age-weighted average approach has been used to determine intakes for a combined child/adult recreational/trespasser population and a child/adult residential population. The intake equations utilizing the age-weighted average approach are presented in Attachment III. The age-weighted intakes have been calculated through the use of age-adjusted factors. The following age-adjusted factors have been calculated:

- dermal factor (DF) for soils, sediment, surface water and groundwater;
- ingestion factor (IF) for soils, surface water and groundwater; and
- inhalation factor (IHF) for soils, surface water and groundwater.

TABLE A4-4
SUMMARY OF GENERAL INTAKE EQUATIONS^a
RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

1. POTENTIAL DERMAL CONTACT WITH CONSTITUENTS IN SOIL OR SEDIMENT:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{\text{CS} \times \text{CF} \times \text{SA} \times \text{AF} \times \text{ABS} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

- CS = Constituent Concentration in Soil or Sediment (mg/kg)
CF = Conversion Factor (10⁻⁶ kg/mg)
SA = Skin Surface Area Available for Contact (cm²/event)
AF = Soil to Skin Adherence Factor (mg/cm²)
ABS = Absorption Factor (unitless)
EF = Exposure Frequency (events/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (days)

2. POTENTIAL INCIDENTAL INGESTION OF CONSTITUENTS IN SOIL OR SEDIMENT:

$$\text{Intake (mg/kg-day)} = \frac{\text{CS} \times \text{IR} \times \text{CF} \times \text{FI} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

- CS = Constituent Concentration in Soil or Sediment (mg/kg)
IR = Ingestion Rate (mg/day)
CF = Conversion Factor (10⁻⁶ kg/mg)
FI = Fraction Ingested from Source (unitless)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (days)

TABLE A4-4 (Continued)

SUMMARY OF GENERAL INTAKE EQUATIONS^a

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

**3. POTENTIAL INHALATION OF AIRBORNE VAPORS AND/OR PARTICULATES
FROM SOIL OR SEDIMENT:**

$$\text{Intake (mg/kg-day)} = \frac{\text{CA} \times \text{IR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

CA = Constituent Concentration in Air (mg/m³)^b

(Note: $\text{CA} = \text{CS} \left(\frac{1}{\text{VF}} + \frac{1}{\text{PEF}} \right)$)

IR = Inhalation Rate (m³/hour)

ET = Exposure Time (hours/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT = Averaging Time (days)

**4. POTENTIAL DERMAL CONTACT WITH CONSTITUENTS IN GROUNDWATER
OR SURFACE WATER:**

$$\text{Absorbed Dose (mg/kg-day)} = \frac{\text{CW} \times \text{SA} \times \text{PC} \times \text{ET} \times \text{EF} \times \text{ED} \times \text{CF}}{\text{BW} \times \text{AT}}$$

CW = Constituent Concentration in Groundwater or Surface Water (mg/L)

SA = Skin Surface Area Available for Contact (cm²)

PC = Constituent-Specific Dermal Permeability Constant (cm/hour)

ET = Exposure Time (hours/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

CF = Volumetric Conversion Factor for Water (1 liter/1,000 cm³)

BW = Body Weight (kg)

AT = Averaging Time (days)

TABLE A4-4 (Continued)

SUMMARY OF GENERAL INTAKE EQUATIONS^a

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

5. POTENTIAL INGESTION OF CONSTITUENTS IN DRINKING WATER:

$$\text{Intake (mg/kg-day)} = \frac{\text{CW} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

CW = Constituent Concentration in Water (mg/L)

IR = Ingestion Rate (liters/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT = Averaging Time (days)

6. POTENTIAL INGESTION OF CONSTITUENTS WHILE WADING:

$$\text{Intake (mg/kg-day)} = \frac{\text{CW} \times \text{CR} \times \text{ET} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

CW = Constituent Concentration in Water (mg/L)

CR = Contact Rate (liters/hour)

ET = Exposure Time (hours/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT = Averaging Time (days)

TABLE A4-4 (Continued)

SUMMARY OF GENERAL INTAKE EQUATIONS^a

**RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI**

**7. POTENTIAL INHALATION OF AIRBORNE (VAPOR PHASE) CONSTITUENTS
FROM GROUNDWATER OR SURFACE WATER:**

$$\text{Intake (mg/kg-day)} = \frac{(C_w \times K) \times IR \times ET \times EF \times ED}{BW \times AT}$$

C_w = Constituent Concentration in Water (mg/L)

K = Volatilization Factor (liters/m³)^c

(Note: $C_w \times K = CA$ or Chemical Concentration in Air (mg/m³))

IR = Inhalation Rate (m³/hour)

ET = Exposure Time (hours/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT = Averaging Time (days)

^aSource: USEPA (1989a).

^bConcentrations in surficial soils are converted to concentrations in air through the use of a particulate emission factor (PEF) (for inhalation of particulates, all constituents of interest) or a volatilization factor (VF) (for inhalation of vapors, volatile constituents of interest) (USEPA, 1991b). See Attachment II.

^cSource: USEPA, 1991b.

The development of the IF, DF, and IHF for the recreational/trespasser and residential child/adult populations is presented in Attachment III.

It should be noted that the intakes calculated with the equations presented in Table A4-4 are expressed as the amount of chemical at the exchange boundary of the body (e.g., GI tract, lungs) and available for absorption for the ingestion pathways. Because specific values from the USEPA are not currently available or widely accepted for the dermal exposure route, dermal absorption factors from the USEPA Region IV Supplemental Risk Assessment Guidance (USEPA Region IV, 1992) have been applied for assessing potential dermal exposure to site constituents in soil.

Variables used in the intake equations are briefly described in the paragraphs below. Specific exposure parameter values which were used to quantify intakes are given in Attachment III for each different receptor population, medium, and exposure route.

Exposure Concentration (CS, CW, or CA). The concentration term in the intake equation (for soil/sediment, water, or air, respectively) is the exposure point concentration, or that amount of a constituent which is expected to be contacted over the exposure period. Exposure concentrations are based on measured data, with the exception of air, for which a model was utilized to obtain concentrations (see Attachment II). Because of the uncertainty associated with any estimate of exposure concentration, the USEPA recommends using the upper 95th percent confidence limit on the arithmetic mean for this variable (USEPA, 1989a). These limits were calculated as described in Section A3.0, and were previously summarized in Tables A3-2 through A3-6 for the various site media. Maximum concentrations were used to represent constituent concentrations when 95th percent limits exceeded the maximum concentration measured.

Age-Adjustment Factors (IF, DF, and IHF). As discussed above, for some populations, risk estimates associated with the child population(s) are considered together with risk estimates associated with the adult populations to take into account the possibility that a child may later contact site constituents throughout adulthood (USEPA, 1991a). Attachment III includes the age-adjusted factors calculated for the recreational/trespasser and residential populations.

Body Weight (BW). Values for body weight are the average body weight over the exposure period. Separate body weights for children (7 to 18 years old) and adults (43 kg and 70 kg, respectively) were used in the age-weighted factors used to calculate intakes for the child/adult recreational population (see Attachment III). The body weight for children was derived by averaging body weights (50th percentile) given in USEPA's *Exposure Factors Handbook* (USEPA, 1989b) for males and females ages 7 to 18 years old. An adult body weight of 70 kg is the standard body weight for adults as recommended in the MDEQ guidance (MDEQ, 1990) and the current federal risk assessment guidance (USEPA, 1989a). Separate body weights for children and adults (15 kg (1 to 6 years old) and 70 kg, respectively) were used in the age-weighted factors for the residential child/adult population. The body weight used to represent the residential child was derived by averaging body weights (50th percentile) for males and females ages 1 to 6 years old (USEPA, 1989b). All occupational populations were assumed to be comprised of adults, and 70 kg was used as the standard body weight (see Attachment III).

Averaging Time (AT). The averaging time depends on the type of toxic effect being assessed. When evaluating longer-term exposure to noncarcinogens, intakes are calculated by averaging intakes over the period of exposure (i.e., exposure duration, ED). For carcinogens, intakes are calculated by prorating the total cumulative dose over a lifetime (i.e., chronic daily intakes, also called lifetime average daily intake). This distinction relates to the currently held scientific opinion that the mechanism of action for potential carcinogenic and chronic toxic (noncarcinogenic) effects is different. The approach for carcinogens is based on the assumption that a high dose received over a short period of time is equivalent to a corresponding low dose spread over a lifetime (USEPA, 1989a).

Absorption Factor (ABS). Absorption factors (used when assessing potential exposures by dermal contact with constituents in soil) result in an estimation of the absorbed dose rather than administered dose (i.e., the amount of chemical in contact with the skin). Absorption factors are used to reflect the desorption of a chemical from soil and the absorption of a chemical across the skin and into the bloodstream. As previously discussed, there are no widely accepted factors in the current federal guidance, therefore dermal absorption factors were from current USEPA Region IV

guidance: 1.0 percent for organics and 0.1 percent for inorganics (USEPA Region IV, 1992).

Soil to Skin Adherence Factor (AF). AF factors estimate the amount of soil which adheres to skin. The recently released federal dermal exposure guidance document (USEPA, 1992b) recommends a default upper value of 1 mg/cm² to represent the soil to skin adherence rate.

Ingestion Rate (IR). Ingestion rate is used to estimate that amount of a medium ingested when assessing potential exposures by ingestion of soil, surface water, or groundwater. The IRs for the various populations which were determined to have potential exposures via ingestion of these three media are as follows:

- **Occupational Maintenance Worker Population:** The incidental soil ingestion rate for the maintenance worker was assumed as 50 mg/day, which represents adult soil ingestion in the work place (USEPA, 1991a).
- **Occupational Construction Worker Population:** USEPA recommends an IR of 480 mg/day be used for the construction worker population (USEPA, 1991a). This value is based on a modeled value referenced in USEPA's Standard Default Exposure Factors (USEPA, 1991a).
- **Recreational/Trespasser Child/Adult Population:** Age-adjusted factors were used to evaluate all recreational/trespasser ingestion routes. In calculating the age-adjusted factor for the incidental ingestion of soil, a child ingestion rate of 100 mg soil/day was assumed (USEPA, 1989a). This rate was also used to represent the adult ingestion rate (USEPA, 1989a).
- **Residential Child/Adult Population:** Age-adjusted factors were used to evaluate all residential ingestion routes. In calculating the age-adjusted factor for the incidental ingestion of soil, a child ingestion rate of 200 mg soil/day was assumed, and the ingestion rate of 100 mg soil/day was used to represent the adult (MDEQ, 1990; USEPA, 1991a). For the age-adjusted factor for ingestion of groundwater, an ingestion rate of 1.0 L/day was assumed for the child (USEPA, 1989b), and 2.0 L/day was assumed to represent the adult (MDEQ, 1990; USEPA, 1991a).

Contact Rate (CR). A contact rate is used to estimate the rate of ingestion of surface water while swimming (or wading). The default CR of 0.05 liters per hour was assumed to represent both the child and adult in the recreational/trespasser population (USEPA, 1989a).

Inhalation Rate (IR). Inhalation rate is used to estimate the amount of air inhaled when assessment potential exposures by inhalation of vapors and/or particulates from soil, sediment, surface water or groundwater. The IRs for the various populations which were determined to have potential exposures via inhalation from these four media are as follows:

- **Occupational Maintenance Worker Population:** The inhalation rate for the maintenance worker was assumed as 0.83 m³/hr (20 m³/day) which represent an adult inhalation rate (MDEQ, 1990; USEPA, 1989a).
- **Occupational Construction Worker Population:** The inhalation rate for the construction worker population for inhalation from exposures to soil was assumed as 0.83 m³/hr, which represents an adult inhalation rate (MDEQ, 1990; USEPA, 1989a).
- **Recreational/Trespasser Child/Adult Population:** In calculating the age-adjusted factor for the evaluation of inhalation exposure routes for soil or surface water, a child inhalation rate of 2.5 m³/hr was assumed (USEPA, 1989b). The inhalation rate of 0.83 m³/hr was assumed for the adult (MDEQ, 1990; USEPA, 1989a).
- **Residential Child/Adult Population:** In calculating the age-adjusted factor for the evaluation of inhalation exposure routes for soil or groundwater, a child inhalation rate of 1.8 m³/hr was assumed (USEPA, 1989b). The inhalation rate of 0.83 m³/hr was assumed for an adult (MDEQ, 1990; USEPA, 1989a).

Fraction Ingested (FI). The FI is used to account for the fraction of ingested material that is presumed to be contaminated. For soil at the project site, an FI of

1.0 was used, which conservatively assumes that all soil incidentally ingested contains site constituents of interest.

Volatilization Factor (K). The volatilization factor is used to estimate inhalation exposure to volatiles released from water. A K value of 0.5 liter/m³ was assumed for all volatiles with Henry's Law Constants greater than 10⁻⁵ and molecular weights less than 200 (USEPA, 1991a). This factor was used to convert groundwater and surface water concentrations to airborne concentrations.

Permeability Constant (PC). Permeability constants (used when assessing potential exposures by dermal contact with constituents in water) reflect the movement of a chemical across the skin and into the bloodstream and result in an estimation of the absorbed dose rather than the amount of chemical that comes in contact with the skin. The PC values assumed are recommended values from USEPA's interim guidance on dermal exposures (USEPA, 1992b). PC values for the constituents of interest in water (i.e., groundwater and surface water) are presented in Attachment III.

The remaining variables used in the intake equations (exposure frequency (EF) and exposure duration (ED) for all equations; exposure time (ET) for the inhalation intake equation; and surface area (SA) for the dermal contact intake equation) are specific to the activity conducted and the population conducting the activity. These variables are discussed separately below.

Exposure Frequency (EF) and Exposure Duration (ED). Exposure frequency and duration are used to estimate the total time of exposure. The EFs and EDs for the various populations which were determined to have potential exposures at the site are as follows:

- **Occupational Maintenance Worker Population:** An EF of 50 days/year was used to represent the maintenance worker, based on the assumption that outdoor activities would take place one day per week (professional judgment) for 50 weeks per year (USEPA, 1991a). An ED of 25 years was assumed, to represent the USEPA's default occupational exposure duration (USEPA, 1991a), which is based on the assumption that one individual works at the same location for 25 years.

- **Occupational Construction Worker Population:** An EF of 250 days/year was used to represent the construction worker population, based on the assumption that a construction worker would work 5 days/week for 50 weeks/year at the same location (USEPA, 1991a). The ED was assumed to be 1 year, based on professional judgment that it would take 1 year to complete most construction/renovation projects.
- **Recreational/Trespasser Child/Adult Population:** In calculation of the age-adjusted intakes, an EF of 50 days per year was assumed for children, assuming one day per week (professional judgment) for 50 weeks per year (USEPA, 1991a). An ED of 12 years (7 to 18 years old) was used for the child based on professional judgment. An EF of 50 days per year was also assumed for the adult. An ED of 18 years was assumed for the adult, based on professional judgment. Overall, the recreational/trespasser population is evaluated for an ED of 30 years (i.e., 12 years as a child and 18 years as an adult) to represent the USEPA's default recreational exposure duration (USEPA, 1991a).
- **Residential Child/Adult Population:** In calculating the age-adjusted intakes, an EF of 350 days per year was assumed for both the child and the adult based on the USEPA's default residential exposure frequency (USEPA, 1991a). An ED of 6 years (1 to 6 years old) was assumed for the child and an ED of 24 years was assumed for the adult. Overall, the residential population is evaluated for an ED of 30 years (i.e., 6 years as a child and 24 years as an adult) to represent the USEPA's default residential exposure duration of 30 years (USEPA, 1991a).

Exposure Time (ET). ET (hours/day) is used in the inhalation intake equation. The ET used for the construction worker was 8 hours/day based on the professional judgment that a worker would spend the full work day out-of-doors. An ET of 4 hours/day was used for the inhalation routes for the maintenance worker, based on the conservative assumption that the worker would spend four hours of a work day out-of-doors. This ET was also used to evaluate the maintenance worker dermal contact exposure to surface water. An ET of two hours per day was assumed for the recreational/trespasser and residential populations. This ET is used to evaluate

inhalation routes for the recreational/trespasser population, as well as the incidental ingestion and dermal contact exposure to surface water. The ET of 2 hours/day for the residential population applies only to the inhalation route (from soils). For the residential dermal contact and inhalation exposures to groundwater while showering, an ET of 0.25 hr/day (15 minutes) was assumed (USEPA, 1992b).

Skin Surface Area Available for Contact (SA). To estimate potential exposures through dermal contact with soil, an SA must be assumed. Both 95th and 50th percentile body part-specific surface areas are available, but it is recommended that the 50th percentile be used (USEPA, 1989a). The new dermal guidance *Dermal Exposure Assessment: Principles and Applications*, recommends the use of 25 percent of the total body surface area to represent SA for soil contact scenarios (USEPA, 1992b). This default has also been used for the sediment and surface water contact scenarios, based on professional judgment. Per the new dermal guidance, for dermal contact with groundwater while showering, estimates of total body surface area should be used (USEPA, 1992b). The SAs assumed for the populations of interest are as follows:

- **Occupational Populations (Maintenance and Construction Workers):** For occupational populations, 25 percent of an adult body total surface area was assumed, resulting in an SA of 5,800 cm² (USEPA, 1992b).
- **Recreational/Trespasser Child/Adult Population:** For the age-adjusted intakes an SA of 3,380 cm² (25 percent of the total child body surface area) was assumed for children, and an SA of 5,800 cm² (25 percent of the total adult body surface area) was assumed for adults (USEPA, 1992b).
- **Residential Child/Adult Population:** For the age-adjusted intakes for dermal contact exposure to soil an SA of 1,800 cm² (25 percent of the total body surface area) was assumed for the child, and an SA of 5,800 cm² (25 percent of total adult body surface area) was assumed for the adult (USEPA, 1992b). For the age-adjusted intakes for dermal contact exposure to groundwater while showering, an SA of 8,500 cm² (total child body

surface area) was assumed for the child, and an SA of 23,000 cm² (total adult body surface area) was assumed for the adult (USEPA, 1992b).

A4.3 SUMMARY OF INTAKES

Summaries of the estimated intakes of site constituents for populations described in Tables A4-1 through A4-3 using the media concentrations, intake equations, and exposure assumptions described earlier in this section are presented in Attachment VI.

A5.0 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to weigh available evidence regarding the potential of constituents of interest to cause adverse effects in exposed individuals, and to provide, where possible, an estimate of the relationship between the extent of exposure to a constituent and the increased likelihood and/or severity of adverse effects in humans (USEPA, 1989a).

Toxicity assessments for Superfund sites are generally accomplished in two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining whether exposure to a constituent can cause an increase in the incidence of an adverse health effect (e.g., cancer), and whether the effect is likely to occur in humans. The dose-response evaluation is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the constituent and the adverse health effects in an exposed population. From this quantitative dose-response relationship, toxicity values (further discussed below) may be derived and further used to estimate the incidence of adverse effects as a function of potential human exposure to the constituent (USEPA, 1989a). These toxicity values are used later in the risk characterization (see Section A6.0) step of the baseline risk assessment process to quantify potential human exposures to site constituents.

A5.1 SOURCES OF TOXICITY INFORMATION

Although the toxicity assessment is an integral component of the baseline risk assessment process, the amount and type of toxicological information available are limited in most cases (USEPA, 1989a). The USEPA has performed the toxicity assessment step for numerous chemicals and has made available the resulting toxicity information and toxicity values through its on-line toxicity database, the Integrated Risk Information System (IRIS). IRIS was originally developed to make chemical-specific risk information readily available to the USEPA and state agencies involved in risk assessments, and to promote consistency in the performance of risk assessments and subsequent risk management decisions. The information contained in Section I (Chronic Health Hazard Assessment for Noncarcinogenic Effects) and Section II (Carcinogenicity Assessment for Lifetime Exposure) of the IRIS chemical files represents a consensus judgment of USEPA's Reference

Dose (RfD) Work Group or Carcinogen Risk Assessment Verification Endeavor (CRAVE) Work Group, respectively. These two Agency-wide Work Groups include scientists from USEPA's program offices (e.g., hazardous waste, air, pesticides) and the Office of Research and Development. Individual USEPA offices have conducted comprehensive scientific reviews of the literature available on particular chemicals, and have performed the hazard evaluation and dose-response assessment. These assessments have been summarized for IRIS and reviewed and revised by the appropriate Work Group. As new information becomes available, these Work Groups re-evaluate their work and revise IRIS files accordingly. Because the toxicity information is constantly being updated, IRIS is currently only available on-line. As of April 1988, the IRIS database was made available to the public, and all USEPA staff, USEPA contractors, and PRPs (or their consultants) are expected to use IRIS as the primary source of toxicity information in performing risk assessments (*Federal Register*, 1988).

Second to IRIS, the USEPA recommends that the Health Effects Assessment Summary Tables (HEASTs) be consulted. Formerly called "The Quarterly" and associated references, HEASTs are tabular presentations of toxicity information and values for chemicals for which Health Effects Assessments (HEAs), Health and Environmental Effects Documents (HEEDs), Health and Environmental Effects Profiles (HEEPs), Health Assessment Documents (HADs), or Ambient Air Quality Criteria Documents (AAQCDs) have been prepared. The HEASTs summarize interim (pending IRIS verification) RfDs for noncarcinogens and slope factors (SFs) for potential carcinogens, as well as other toxicity information for specific chemicals. Therefore, the HEASTs are especially helpful when verified information for a chemical is pending Work Group concurrence on the final database file and the toxicity values are not yet available in the IRIS database. Currently, the HEAST is to be issued each year as an annual edition with quarterly supplements. Each quarterly supplement will incorporate all information in the previous supplement and therefore replace the previous supplement. Information in the supplements will supersede the information in the annual update. The latest available HEAST at the time of this investigation include the March 1993 HEAST Annual Update (USEPA, 1993a) and the July 1993 Supplement No. 1 (USEPA, 1993b).

Toxicity values are derived separately for potential carcinogens and noncarcinogens, and verified values are currently only available for the inhalation and ingestion

routes, for chronic exposures (USEPA, 1989a). The USEPA has values available for a selected list of hazardous chemicals in IRIS and is constantly updating the list and the values. Therefore, consistent with USEPA's risk assessment guidance (USEPA, 1989a), for the purposes of quantifying potential baseline risks associated with the site, if RfD or SF values were not available at the time of the investigation (or able to be derived) either from IRIS as of December 1993 or the most recent HEAST (USEPA, 1993a; USEPA 1993b), potential risks will not be quantified in the Risk Characterization (Section A6.0).

A5.2 TOXICITY VALUES FOR NONCARCINOGENIC EFFECTS

As mentioned above, the types of toxicity values for noncarcinogenic effects are the chronic Reference Doses (RfDs, formerly called ADIs or AICs). The chronic RfD is an estimate of the daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime, usually in units of mg/kg-day. The greater the value of the RfD, the less toxic the chemical; doses that are less than the RfD are not likely to be associated with adverse health effects. Usually, as the frequency of exposures exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse health effects may be expected in a human population. RfDs are usually determined from laboratory studies on animals, using a lowest-observed-adverse-effect-level (LOAEL) or a no-observed-adverse-effect-level (NOAEL), divided by appropriate uncertainty factors and modifying factors to account for differences in human and animal sensitivities, etc. Noncarcinogens are usually assumed to have a "threshold," i.e., a level or dose below which no adverse or toxic effects will occur. Carcinogens, as evaluated by USEPA dose-response methods, are assumed to have no such threshold. Currently, RfDs for selected chemicals may be available for two routes of exposure: ingestion and inhalation. It should be noted that noncarcinogenic effects, carcinogenic effects, or both types of effects may be associated with a single constituent.

A5.3 TOXICITY VALUES FOR POTENTIAL CARCINOGENIC EFFECTS

The carcinogenicity of a given potential carcinogen is generally described by a slope factor (SF), in units of (mg/kg-day)⁻¹. Slope factors are derived for chronic or lifetime exposures. The higher the SF, the more potent is a carcinogen and the more

likely the probability that a given concentration of a chemical may result in the incidence of cancer. Currently, SFs for selected chemicals may be available for two routes of exposure: ingestion and inhalation. Slope factors are not available for all potential carcinogens; also, an inhalation value and/or an ingestion value (or neither), may be available. The cancer SF is usually obtained from animal studies, and is the upper 95th percent confidence limit of the slope of a dose-response curve generated using conservative models and assumptions (USEPA, 1989a).

In assessing the carcinogenic potential of a constituent, the USEPA classifies the constituent into one of the following classes, according to the "weight of evidence" from epidemiological studies and/or animal studies:

- Class A Human Carcinogen (sufficient evidence of carcinogenicity in humans);
- Class B Probable Human Carcinogen (B1--limited evidence of carcinogenicity in humans; B2--sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans);
- Class C Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data);
- Class D Not Classifiable as to Human Carcinogenicity (inadequate or no evidence); and
- Class E Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies).

Quantitative carcinogenic risk assessments are performed for chemicals in Groups A and B, and on a case-by-case basis for chemicals in Group C. Quantitative carcinogenic risk assessments are not performed for chemicals in Groups D or E (USEPA, 1989a).

Another quantitative form of carcinogenic potential occasionally given instead of a SF is a "unit cancer risk" value. The unit cancer risk is route-specific (i.e., inhalation or ingestion), and is expressed as the amount of risk associated with a

given constituent per concentration unit in air or water (e.g., risk per $\mu\text{g/L}$ of water). A SF may be approximated for chemicals for which no slope factors are provided from the unit risk values by using standard intake assumptions (e.g., ingestion of 2 liters of water/day) and solving for the slope factor in the following equations:

Risk per $\mu\text{g}/\text{m}^3$ (air) =

$$\text{Slope Factor } (\text{mg}/\text{kg}\cdot\text{d})^{-1} \times \frac{1}{70 \text{ kg}} \times 20 \text{ m}^3/\text{day} \times 10^{-3} \text{ mg}/\mu\text{g}$$

Risk per $\mu\text{g}/\text{L}$ (water) =

$$\text{Slope Factor } (\text{mg}/\text{kg}\cdot\text{d})^{-1} \times \frac{1}{70 \text{ kg}} \times 2 \text{ L}/\text{day} \times 10^{-3} \text{ mg}/\mu\text{g}$$

As further discussed in Section A6.0, in the baseline risk assessment, potential health risks from exposure to constituents are estimated by using these toxicity values, along with measured (or modeled) concentrations of the site constituents in relevant site media. The measured or predicted concentrations of the constituents are used with various intake factors (e.g., rate of water ingestion) and the toxicity values to estimate potential human health risks. For carcinogens, the intake values are then multiplied by the appropriate SFs to estimate the potential frequency of cancer risks (e.g., 1 in 100,000 or 1×10^{-5} risk). For noncarcinogens, the intake values are expressed as a ratio with the appropriate RfD value.

A5.4 AVAILABLE TOXICITY VALUES FOR CONSTITUENTS OF INTEREST

The latest available SFs and RfDs for inhalation and oral exposure routes for the constituents of interest at the site are presented in Table A5-1 (from the sources discussed previously in Section A5.1). Complete toxicity profiles for each of the constituents of interest which were on file in IRIS (as of December 1993) are provided in Attachment IV.

Of the 51 constituents of interest presented in Table A5-1, seven constituents (aluminum, iron, lead, 2-methylnaphthalene, naphthalene, phenanthrene, and

TABLE A5-1

SUMMARY OF TOXICITY VALUES USED IN RISK CALCULATIONS

RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	CAS No.	Oral Slope Factor (SF) (mg/kg-day) ⁻¹	Wgt ^a	Source ^b	Oral Chronic RfD (mg/kg-day)	Source ^b	Inhalation Slope Factor (mg/kg-day) ⁻¹	Wgt ^a	Source ^b	Inhalation Chronic RfD (mg/kg-day)	Source ^b
Acetone	67-64-1	ND	D	(1)	0.1	(1)	ND	D	(1)	ND	(1)(2)
Aluminum	7429-90-5	ND	ND	(1)(2)	ND	(1)(2)	ND	ND	(1)(2)	ND	(1)(2)
Antimony	7440-36-0	ND	ND	(1)(2)	0.0004	(1)	ND	ND	(1)(2)	ND	(1)(2)
Arsenic	7440-38-2	1.8 ^c	A	(1)	0.0003	(1)	50 ^d	A	(2)	ND	(1)(2)
Barium	7440-39-3	ND	ND	(1)(2)	0.07	(1)	ND	ND	(1)(2)	0.0001	(2)
Benzene	71-43-2	0.029	A	(1)	ND	(1)(2)	0.029 ^d	A	(2)	ND	(1)(2)
bis(2-Ethylhexyl)phthalate	117-81-7	0.014	B2	(1)	0.02	(1)	ND	B2	(1)	ND	(1)(2)
2-Butanone (MEK)	78-93-3	ND	D	(1)	0.6	(1)	ND	D	(1)	0.29 ^e	(1)
Butyl benzyl phthalate	85-68-7	ND	C	(1)	0.2	(1)	ND	C	(1)	ND	(1)(2)
Carbon tetrachloride	56-23-5	0.13	B2	(1)	0.0007	(1)	0.053 ^d	B2	(2)	ND	(1)(2)
Chloroform	67-66-3	0.0061	B2	(1)	0.01	(1)	0.081 ^d	B2	(2)	ND	(1)(2)
2-Chlorophenol	95-57-8	ND	ND	(1)(2)	0.005	(1)	ND	ND	(1)(2)	ND	(1)(2)
Chromium (III)	16065-83-1	ND	ND	(1)(2)	1	(1)	ND	ND	(1)(2)	ND	(1)(2)
Chromium (VI)	7440-47-3	ND	A	(1)	0.005	(1)	41 ^d	A	(2)	ND	(1)(2)
Copper	7440-50-8	ND	D	(1)	0.037 ^f	(2)	ND	D	(1)	ND	(1)(2)
Cyanide (free)	57-12-5	ND	D	(1)	0.02	(1)	ND	D	(1)	ND	(1)(2)
4,4'-DDE	72-55-9	0.34	B2	(1)	ND	(1)(2)	ND	B2	(1)	ND	(1)(2)
1,4-Dichlorobenzene	106-46-7	0.024	B2	(2)	ND	(1)(2)	ND	ND	(1)(2)	ND	(1)(2)
1,2-Dichloroethane	107-06-2	0.091	B2	(1)	ND	(1)(2)	0.091 ^d	ND	(1)(2)	0.2 ^e	(2)
1,1-Dichloroethene	75-35-4	0.6	C	(1)	0.009	(1)	1.2	C	(2)	ND	(1)(2)
1,2-Dichloroethene (cis)g	156-59-2	ND	D	(1)	0.01	(2)	ND	D	(1)	ND	(1)(2)
1,2-Dichloroethene (trans)g	156-60-5	ND	ND	(1)(2)	0.02	(1)	ND	ND	(1)(2)	ND	(1)(2)
Diethyl phthalate	84-66-2	ND	D	(1)	0.8	(1)	ND	D	(1)	ND	(1)(2)
Di-n-octyl phthalate	117-84-0	ND	ND	(1)(2)	0.02	(2)	ND	ND	(1)(2)	ND	(1)(2)
Ethyl benzene	100-41-4	ND	D	(1)	0.1	(1)	ND	D	(1)	0.29 ^e	(1)
Fluoranthene	206-44-0	ND	D	(1)	0.04	(1)	ND	D	(1)	ND	(1)(2)

TABLE A5-1 (Continued)

SUMMARY OF TOXICITY VALUES USED IN RISK CALCULATIONS

RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	CAS No.	Oral Slope Factor (SF) (mg/kg-day) ⁻¹	Wgt ^a	Source ^b	Oral Chronic RfD (mg/kg-day)	Source ^b	Inhalation Slope Factor (mg/kg-day) ⁻¹	Wgt ^a	Source ^b	Inhalation Chronic RfD (mg/kg-day)	Source ^b
Fluorene	86-73-7	ND	D	(1)	0.04	(1)	ND	D	(1)	ND	(1)(2)
Iron	7439-89-6	ND	ND	(1)(2)	ND	(1)(2)	ND	ND	(1)(2)	ND	(1)(2)
Isophorone	78-59-1	0.00095	C	(1)	0.2	(1)	ND	C	(1)	ND	(1)(2)
Lead	7439-92-1	ND	B2	(1)	ND	(1)(2)	ND	B2	(1)	ND	(1)(2)
Manganese	7439-96-5	ND	D	(1)	0.005(W); 0.14(F)	(1)	ND	D	(1)	1.4E-05 ^e	(1)
Methylene chloride (Dichloromethane)	75-09-2	0.0075	B2	(1)	0.06	(1)	0.0016 ^h	B2	(1)	0.86 ^e	(2)
2-Methylnaphthalene	91-57-6	ND	ND	(1)(2)	ND	(1)(2)	ND	ND	(1)(2)	ND	(1)(2)
4-Methyl-2-pentanone	108-10-1	ND	ND	(1)(2)	0.05	(2)	ND	ND	(1)(2)	0.02	(2)
Naphthalene	91-20-3	ND	D	(1)	ND	(1)(2)	ND	D	(1)	ND	(1)(2)
Nickel (soluble salts)	7440-02-0	ND	ND	(1)(2)	0.02	(1)	ND	ND	(1)(2)	ND	(1)(2)
n-Nitrosodiphenylamine	86-30-6	0.0049	B2	(1)	ND	(1)(2)	ND	B2	(1)	ND	(1)(2)
Pentachlorophenol	87-86-5	0.12	B2	(1)	0.03	(1)	ND	B2	(1)	ND	(1)(2)
Phenanthrene	85-01-8	ND	D	(1)	ND	(1)(2)	ND	D	(1)	ND	(1)(2)
Phenol	108-95-2	ND	D	(1)	0.6	(1)	ND	D	(1)	ND	(1)(2)
1,1,2,2-Tetrachloroethane	79-34-5	0.2	C	(1)	ND	(1)(2)	0.2 ^d	C	(2)	ND	(1)(2)
Tetrachloroethene	127-18-4	ND	ND	(1)(2)	0.01	(1)	ND	ND	(1)(2)	ND	(1)(2)
Toluene	108-88-3	ND	D	(1)	0.2	(1)	ND	D	(1)	0.11 ^e	(1)
1,2,4-Trichlorobenzene	120-82-1	ND	D	(1)	0.01	(1)	ND	D	(1)	0.003	(1)
1,1,1-Trichloroethane	71-55-6	ND	D	(1)	ND	(1)(2)	ND	D	(1)	ND	(1)(2)
1,1,2-Trichloroethane	79-00-5	0.057	C	(1)	0.004	(1)	0.057 ^d	C	(2)	ND	(1)
Trichloroethene	79-01-6	0.011	ND	(3)	ND	(1)(2)	0.006	ND	(3)	ND	(1)(2)
Trichlorofluoromethane	79-69-4	ND	ND	(1)(2)	0.3	(1)	ND	ND	(1)(2)	0.2	(2)

TABLE A5-1 (Continued)

SUMMARY OF TOXICITY VALUES USED IN RISK CALCULATIONS

RANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Constituent	CAS No.	Oral Slope Factor (SF) (mg/kg-day) ⁻¹	Wgt ^a	Source ^b	Oral Chronic RfD (mg/kg-day)	Source ^b	Inhalation Slope Factor (mg/kg-day) ⁻¹	Wgt ^a	Source ^b	Inhalation Chronic RfD (mg/kg-day)	Source ^b
Vinyl chloride	75-01-4	1.9	A	(2)	ND	(1)(2)	0.3	A	(2)	ND	(1)(2)
Xylene(total)	1330-20-7	ND	D	(1)	2	(1)	ND	D	(1)	ND	(1)(2)
Zinc	7440-68-6	ND	D	(1)	0.3	(1)	ND	D	(1)	ND	(1)(2)

^aWgt = weight of evidence classification for carcinogens.^bSources of toxicity information: (1) IRIS (12/93); (2) HEAST (USEPA, 1993a; USEPA, 1993b); (3) USEPA Region IV memo (see Attachment V).^cOral slope factor for arsenic is based on a unit risk of 5E-05 (μg/L)⁻¹.^dA unit risk value is also available for this constituent in IRIS (12/93).^eInhalation RfDs were calculated from unit risk values in mg/m³.^fOral RfD for copper was calculated from the 1.3 mg/L drinking water standard.^gAlthough total 1,2-Dichloroethene was analyzed for in site samples, toxicity information is available only for the cis and trans isomers. The range of toxicity values for the cis and trans 1,2-Dichloroethene isomers will be used for risk calculation in Section A6.0.^hThe inhalation slope factor for methylene chloride is calculated from a unit risk of 4.7E-07 (μg/m³)⁻¹.

1,1,1-trichloroethane) did not have a current SF or RfD value (for either oral or inhalation routes) listed in either IRIS or the latest available HEAST at the time of this investigation. As discussed in Section A5.1, potential risks will not be quantified in the Risk Characterization (Section A6.0) for these constituents.

Toxicity values for trichloroethene (TCE), a primary constituent of interest at the site, were not available in the latest IRIS database or HEAST. The carcinogenicity assessment for TCE has been withdrawn from the IRIS database (including the slope factors), the oral and inhalation reference dose information is pending, and toxicity information is not available in HEAST. However, USEPA Region IV guidance addresses the issue of the lack of toxicity data for TCE. USEPA Region IV guidance indicates that the TCE carcinogenic toxicity information was withdrawn from IRIS due to controversy over the weight of evidence classification (whether TCE is a B2 or C carcinogen). In fact, the Guidance presents IRIS Carcinogen Risk Assessment Verification Endeavor (CRAVE) Workgroup reviewed oral and inhalation slope factors for use in risk assessment evaluations of TCE (see Attachment V). These values have been used in the calculation of risks (see Section A6.0) for TCE and are presented in Table A5-1.

A5.4.1 Evaluation of Carcinogenic Potential via Ingestion

Available oral SFs and/or the associated weight of evidence classifications (see Section A5.3) are provided in Table A5-1 for the constituents of interest at the site. This information reflects the potential carcinogenic hazard posed by ingestion of the associated constituents.

Of the 51 constituents listed in Table A5-1, 34 did not have a current oral SF listed in either IRIS (as of December 1993), or in the HEAST (USEPA, 1993a; USEPA, 1993b). These constituents are: acetone, aluminum, antimony, barium, 2-butanone, butyl benzyl phthalate, 2-chlorophenol, chromium (III), chromium (VI), copper, cyanide, 1,2-dichloroethene (cis and trans), diethyl phthalate, di-n-octyl phthalate, ethyl benzene, fluoranthene, fluorene, iron, lead, manganese, 2-methylnaphthalene, 4-methyl-2 pentanone, naphthalene, nickel, phenanthrene, phenol, tetrachloroethene, toluene, 1,2,4-trichlorobenzene, 1,1,1-trichloroethane, trichlorofluoromethane, xylene (total), and zinc. This means that data for these

constituents were either not available at the time of this investigation or the constituents are not expected to exhibit carcinogenic effects.

Of the 34 constituents of interest without SFs, 18 are classified as Class "D": acetone, 2-butanone, copper, cyanide, 1,2-dichloroethene (cis), diethyl phthalate, ethyl benzene, fluoranthene, fluorene, manganese, naphthalene, phenanthrene, phenol, toluene, 1,2,4-trichlorobenzene, 1,1,1-trichloroethane, xylene (total), and zinc. As noted earlier in Section A5.3, quantitative risk assessments are not performed for chemicals classified as Class "D" because of inadequate or no evidence of human carcinogenicity. Of the 17 constituents with oral SFs, the toxicity factors ranged from a low value of $0.00095 \text{ (mg/kg-day)}^{-1}$ for isophorone to a high value of $1.9 \text{ (mg/kg-day)}^{-1}$ for vinyl chloride.

Of the 17 constituents for which oral SF values are available, three constituents (arsenic, benzene, and vinyl chloride) are classified as Class "A" (human carcinogen). There is no quantitative estimate of carcinogenic risk from oral exposure from chromium (VI) which is also classified as a Class "A" human carcinogen. The remaining 14 constituents with oral SFs are classified with a "B2" or "C" weight of evidence.

A5.4.2 Evaluation of Chronic Effects Other Than Carcinogenesis via Ingestion

The latest available oral chronic RfDs for the constituents of interest at the site are also presented in Table A5-1. This information reflects the potential noncarcinogenic hazard posed by chronic ingestion of the associated constituents.

Of the 51 constituents listed in Table A5-1, the following 15 did not have a current oral RfD listed in either IRIS (as of December 1993) or in the HEAST (USEPA, 1993a; USEPA, 1993b): aluminum, benzene, 4,4'-DDE, 1,4-dichlorobenzene, 1,2-dichloroethane, iron, lead, 2-methylnaphthalene, naphthalene, n-nitrosodiphenylamine, phenanthrene, 1,1,2,2-tetrachloroethane, 1,1,1-trichloroethane, trichloroethene, and vinyl chloride. This means that data for these constituents are either not available at the time of this investigation, or the constituents are not expected to exhibit chronic toxic effects. The oral RfD values for the remaining 36

constituents ranged from 0.0003 mg/kg-day for arsenic to 2 mg/kg-day for xylene (total).

More than one oral chronic RfD is given for manganese and 1,2-dichloroethene. Manganese has one oral RfD value for intake via water (0.005 mg/kg-day) and another value for intake via food (0.14 mg/kg-day). 1,2-Dichloroethene (1,2-DCE) has a chronic oral RfD value listed for each of two isomeric forms, but no toxicity data for 1,2-DCE (total), which was measured in site samples. The oral RfDs are 0.01 and 0.02 mg/kg-day for the cis- and trans- isomers, respectively. The lower oral chronic RfD of the cis-isomer indicates that it is more toxic than the trans- isomer. An oral RfD also appears in HEAST for 1,2-dichloroethene (mixed isomers). This value, however, was derived from and representative of 1,1-dichloroethylene. For the purposes of risk characterization (Section A6.0) for total 1,2-dichloroethene, it was assumed that measured 1,2-dichloroethene was either 100 percent cis-1,2-DCE or 100 percent trans-1,2-DCE, and the range of oral RfDs for the cis-and trans-isomers were used. Chromium also has two values listed which are related to its chemical form - one for the (VI) valence state (0.005 mg/kg-day), and a much higher value for the (III) valence state, which is a considerably less toxic form of chromium (1.0 mg/kg-day).

A5.4.3 Evaluation of Carcinogenic Potential via Inhalation

The latest available inhalation SFs for the constituents of interest at the site and/or associated weight of evidence classifications are presented in Table A5-1. This information reflects the potential carcinogenic hazard posed by exposure to these constituents via inhalation.

Of the 51 constituents listed in Table A5-1, 39 did not have a current inhalation SF listed in either IRIS (as of December 1993) or in the HEAST (USEPA, 1993a; USEPA, 1993b). This means that data for these constituents are either not available at the time of this investigation, or the constituents are not expected to exhibit carcinogenic effects. These constituents are: acetone, aluminum, antimony, barium, bis(2-ethylhexyl)phthalate, 2-butanone, butyl benzyl phthalate, 2-chlorophenol, chromium (III), copper, cyanide, 4,4'-DDE, 1,4-dichlorobenzene, 1,2-dichloroethene (cis and trans), diethyl phthalate, di-n-octyl phthalate, ethyl benzene, fluoranthene, fluorene, iron, isophorone, lead, manganese,

2-methylnaphthalene, 4-methyl-2-pentanone, naphthalene, nickel, n-nitrosodiphenylamine, pentachlorophenol, phenanthrene, phenol, tetrachloroethene, toluene, 1,2,4-trichlorobenzene, 1,1,1-trichloroethane, trichlorofluoromethane, xylene(total), and zinc. Of these 39 constituents, 18 are classified as Class "D": acetone, 2-butanone, copper, cyanide, 1,2-dichloroethene (cis), diethyl phthalate, ethyl benzene, fluoranthene, fluorene, manganese, naphthalene, phenanthrene, phenol, toluene, 1,2,4-trichlorobenzene, 1,1,1-trichloroethane, xylene (total), and zinc. As noted in Section A5.3, quantitative risk assessments are not performed for chemicals classified as Class "D" because of inadequate or no evidence of human carcinogenicity.

Of the 12 constituents with inhalation SFs, the toxicity factors ranged from a low value of 0.0016 (mg/kg-day)⁻¹ for methylene chloride to a high value of 50 (mg/kg-day)⁻¹ for arsenic. Of these 12 constituents, four were classified as Class "A" human carcinogens: arsenic, benzene, chromium (VI), and vinyl chloride. The other constituents with inhalation SFs were classified as "B2" or "C".

A5.4.4 Evaluation of Chronic Effects Other Than Carcinogenesis via Inhalation

The latest available inhalation chronic RfDs for the site constituents of interest are also presented in Table A5-1. This information reflects the potential noncarcinogenic hazard posed by chronic exposure to these constituents via inhalation.

Of the 51 constituents listed in Table A5-1, only 10 have a current inhalation RfD value listed in either IRIS (as of December 1993), or the latest HEAST (USEPA, 1993a; USEPA, 1993b): barium, 2-butanone, 1,4-dichlorobenzene, ethyl benzene, manganese, methylene chloride, 4-methyl-2-pentanone, toluene, 1,2,4-trichlorobenzene, trichlorofluoromethane. For the remaining 41 constituents, data were either not available at the time of this investigation, or the constituents are not expected to exhibit chronic effects. The available inhalation RfDs ranged from 0.000014 mg/kg-day for manganese to 0.86 mg/kg-day for methylene chloride (the lower RfD represents the more toxic constituent).

A5.5 MODIFIED TOXICITY VALUES FOR EXPOSURE ROUTES

The toxicity data presented in Table A5-1 pertain only to the oral and inhalation (volatiles) exposure routes. As previously discussed in detail in Section A3.0, there is a potential for human receptors to be exposed to site constituents via other exposure routes (e.g., dermal contact; inhalation of particulates) for some exposure pathways.

Although intake equations are now available in the most recent federal risk assessment guidance (USEPA, 1989a) for various exposure routes besides ingestion, insufficient exposure data exist for some of the intake variables, and/or insufficient toxicity data exist to evaluate some exposure routes other than ingestion with any degree of confidence. For example, for the dermal contact exposure route, the intake equation in the current federal guidance (USEPA, 1989a) requires that a "chemical-specific dermal permeability constant" (for constituents in solution) or an "absorption factor" (for constituents in soil/sediment) be used. The use of these values results in an estimate of absorbed dose, rather than administered dose, or the amount of chemical that comes in contact with the skin. Chemical-specific, USEPA-recommended values for these factors are not currently available or widely accepted. Therefore, as was discussed in Section A4.0, dermal absorption factors from USEPA Region IV guidance (1 percent for organics and 0.1 percent for inorganics) have been applied in the quantification of risks associated with soils which are presented in Section A6.0 (USEPA, Region IV, 1992). For risks associated with dermal contact with either groundwater or surface water, permeability constants from the interim report, *Dermal Exposure Assessment: Principles and Applications* (USEPA, 1992b) were used.

There are no toxicity values specific to the dermal exposure route. Furthermore, all of the current toxicity values in IRIS are based on administered (not adsorbed) doses (Personal Communication, 1990), and thus are not appropriate to use in quantifying potential dermal contact risks unless some adjustment of the oral toxicity value is made. A method for making this adjustment is given in an appendix of the current risk assessment guidance (USEPA, 1989a). However, this method involves the use of an absorption efficiency factor, for which very little information or data were given in the current federal risk assessment guidance. For dermal exposure route

calculated for the Randall Textron plant, unadjusted oral toxicity factors were used, and 100 percent absorption was assumed.

Likewise, inhalation toxicity values currently available in IRIS are based upon exposure to the constituent in the vapor phase, not as a particulate. No method for converting vapor phase toxicity values to particulate toxicity values is given in the current federal guidance (USEPA, 1989a), and therefore, such a conversion would require the use of assumptions based on very little data. Therefore, in the inhalation pathways presented in Section A6.0, the inhalation toxicity values are used for both vapor phase and particulate emissions.

Only chronic toxicity values are currently available and verified in USEPA's IRIS database for most constituents of interest (USEPA, 1989a). Therefore, the quantification of exposures of less than a chronic duration (e.g., subchronic) would be based on assumptions based on very little USEPA-approved data. Therefore, only chronic exposures are addressed in this risk assessment.

A6.0 RISK CHARACTERIZATION

This section describes the final step of the baseline health risk assessment process, the Risk Characterization. In this step, the exposure assessment information previously presented in Sections A3.0 and A4.0 and the toxicity assessment information previously given in Section A5.0 are summarized and integrated into quantitative expressions of potential risk to human health presented by the site. Uncertainties associated with the estimation of potential human health risks are also presented. To characterize potential carcinogenic effects, probabilities that an individual may develop cancer over a lifetime of exposure are estimated from projected intakes (discussed in A4.0 and presented in Attachment VI) and chemical-specific dose-response information. To characterize potential chronic noncarcinogenic effects, comparisons are made between projected intakes of substances and chemical-specific toxicity values. Risk characterization also serves as the bridge between risk assessment and risk management, and is therefore a key step in RI/FS decision-making. The results of the risk characterization will be used to help determine whether remedial actions should be taken at the site, and to some extent, what major issues those remedial actions should consider.

In the following sections, the most recent federal Superfund risk characterization methodology (USEPA, 1989a) is described. There are separate discussions for potential carcinogenic and noncarcinogenic chronic effects because the biological effects and the methodology to evaluate these effects differ. In addition, potential risks to current and potential future human receptors will be considered separately. Potential risks from individual pathways (e.g., dermal absorption from soils) and potential risks presented by combinations of multiple pathways (e.g., incidental ingestion and dermal absorption of soils) are also presented.

The result of quantifying potential risks in the baseline risk assessment is not a characterization of absolute risk, and should not be interpreted as such (USEPA, 1989a). Rather, the baseline risk results should be interpreted as a quantitative means for making future remedial action decisions.

A6.1 METHODOLOGY FOR ESTIMATION OF POTENTIAL RISKS

This section describes steps for quantifying potential risks for both carcinogenic and noncarcinogenic chronic effects to be applied to each of the potential current and future exposure scenarios identified in Section A3.7 and A4.0. This is followed in Sections A6.2 and A6.3 by a presentation of the estimates of potential current and future human health risks calculated for the Randall Textron plant site.

Individual Risk Estimates

Carcinogens. For potential human carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to potential carcinogen(s), i.e., incremental or excess individual lifetime cancer risk (e.g., 1×10^{-5} or 1 in 100,000).

Slope factors (SF) were discussed in detail and presented in Section A5.0. In combination with estimated chronic daily intakes (CDIs, previously discussed in Section A4.0 and presented in Attachment VI), a SF for a given constituent averaged over a lifetime of exposure results in an expression of the potential incremental risk of an individual developing cancer in a lifetime from that constituent. Because relatively low intakes (compared to those experienced by test animals) are expected to result from environmental exposures, it is generally assumed that the dose-response relationship will be linear in the low-dose portion of the multistage model dose-response curve (USEPA, 1989a). Under this assumption, the SF is a constant, and risk will be directly related (i.e., proportional) to intake. Thus, the linear form of the carcinogenic risk equation given below is used for chemical-specific risks:

$$\text{Chemical-Specific CR} = \text{CDI} \times \text{SF}$$

where:

- CR = chemical-specific carcinogenic risk, a unitless probability (e.g., 2×10^{-5}) of an individual developing cancer;
- CDI = chronic daily intake averaged over 70 year (mg/kg-day); and
- SF = slope factor (mg/kg-day)⁻¹

Because the SF usually reflects the upper 95th percent confidence limit of the probability of response based on experimental animal data used in the multistage model, the use of the SFs results in a carcinogenic risk estimate which is an upper-bound estimate independent of exposure assumptions (i.e., assumptions affecting the CDI), which may also be a source of inherent conservatism in the risk estimate. This means that the "true" risk will most likely not exceed the risk estimate derived through use of this model, and will most likely be less than that predicted with the model. The choice of the linearized, upper-bound dose-response model is a policy choice, and is neither a "best estimate" nor a "maximum likelihood estimate."

Noncarcinogens. The measure used to describe the potential for noncarcinogenic effects to occur in an individual is not expressed as the probability of an individual experiencing an adverse effect. At the present time, the USEPA does not use a probabilistic approach to estimating the potential for noncarcinogenic chronic health effects. Instead, the potential for noncarcinogenic chronic effects is evaluated by comparing an exposure level (i.e., the CDI) over a specified time period with a reference dose value (RfD). This ratio of exposure to toxicity is called a "hazard quotient", defined below (USEPA, 1989a):

$$\text{Chemical-Specific HQ} = \text{CDI/RfD}$$

where:

HQ = chemical-specific noncarcinogenic hazard quotient

CDI = chronic daily intake (mg/kg-day)

RfD = reference dose (mg/kg-day)

The noncarcinogenic HQ assumes that the level of exposure associated with the RfD is below that which is associated with adverse health effects (including sensitive populations). If the CDI exceeds this threshold (i.e., if CDI/RfD exceeds unity), there may be a potential for noncarcinogenic chronic effects. As a rule, the greater the value of CDI/RfD above unity, the greater the level of concern. However, the ratios of CDI/RfD are not statistical probabilities (i.e., a ratio of 0.001 does not mean that there is a one in one thousand chance of the effect occurring). Further, it is important to emphasize that the level of concern does not increase linearly as the

RfD is approached or exceeded, because the values of RfDs do not have equal degrees of certainty, and are not based on the same severity of toxic effects. Thus, the slopes of the dose-response curve in excess of the RfD can range widely depending on the substance.

Risk Estimates for Multiple Constituents and Pathways

Several of constituents have been identified as being potentially of interest in various media at the Randall Textron plant site. Estimates of potential risk or hazard generated by considering one constituent at a time might underestimate the risks associated with simultaneous exposures to several constituents. Therefore, the USEPA recommends assessing the overall potential for carcinogenic and noncarcinogenic chronic effects posed by multiple constituents simultaneously for a given exposure route. Also, exposures to several constituents from a variety of sources, and by more than one exposure pathway, may need to be considered. Although the calculation procedures differ for carcinogenic and noncarcinogenic chronic effects, both sets of procedures assume dose additivity, because information on specific mixtures of constituents found at waste sites is rarely available. As described in Sections A3.7 and A4.0, several populations considered during this baseline risk assessment may have the potential to be exposed via multiple exposure routes (e.g., occupational maintenance populations may be potentially exposed to constituents in surficial soil through incidental ingestion, inhalation, and dermal contact exposure routes).

Carcinogens. The equation for estimating the incremental individual lifetime carcinogenic risks for simultaneous exposure to more than one carcinogenic constituent (and perhaps, via multiple exposure routes) is given below (USEPA, 1989a):

$$\text{Total CR} = \sum \text{CR}_i$$

where:

Total CR = the total carcinogenic risk, expressed as a unitless probability;
CR_i = chemical-specific risk_i, the risk estimate for the ith substance

The use of this method assumes that there is independence of action by the compounds involved, (i.e., there are no synergistic or antagonistic chemical interactions), and that all chemicals produce the same effect (i.e., cancer).

USEPA's "acceptable" (by policy) incremental carcinogenic risk range for CERCLA sites as cited in the current National Contingency Plan (NCP, *Federal Register*, 1990) is 10^{-4} to 10^{-6} (or one in ten thousand to one in one million). In addition, the NCP specifies that the 10^{-6} level shall be the "point of departure" for potential carcinogens in determining remedial alternatives, indicating the USEPA's preference for more protective remediation. For carcinogens, when an applicable standard does not exist or is not sufficiently protective due to multiple exposures or multiple contaminants, USEPA selects remedies resulting in risks that fall within a range of 10^{-4} to 10^{-6} (*Federal Register*, 1990). USEPA indicates that a site that has a cumulative carcinogenic risk in excess of 1×10^{-4} generally warrants remedial action. However, the upper bound of the risk range (10^{-4}) is not considered a discrete line. A specific risk estimate around 10^{-4} may be considered acceptable if justified under site-specific conditions (USEPA, 1991c).

Noncarcinogens. To assess the overall potential for noncarcinogenic chronic effects posed by more than one constituent, a hazard index (HI) approach has been developed. This approach assumes that simultaneous exposures to more than one noncarcinogen could result in an adverse health effect. It also assumes that the magnitude of the adverse effect will be proportional to the sum of ratios of the exposures to acceptable exposures. The hazard index is equal to the sum of the chemical-specific hazard quotients per exposure pathway. When the hazard index exceeds unity (1.0), there may be concern for potential health effects. While any single constituent with an exposure level greater than the toxicity value will cause the HI to exceed unity, for multiple constituent exposures, the HI can also exceed unity even if no single chemical exposure exceeds its RfD. The equation for calculating the noncarcinogenic chronic hazard index (USEPA, 1989a) is given below:

$$HI = CDI_1/RfD_1 + CDI_2/RfD_2 + \dots + CDI_i/RfD_i$$

where:

HI = total noncarcinogenic chronic hazard index
 CDI_i = total chronic daily intake for the ith substance;
 RfD_i = reference dose for the ith substance

When a constituent was identified as having both potential carcinogenic and noncarcinogenic chronic effects, as a conservative measure, both types of effects were quantified.

When applicable standards are not available or are not sufficiently protective due to multiple exposures or multiple contaminants, USEPA sets remediation goals for noncarcinogenic chemicals such that exposures present no appreciable risk of significant adverse effects to individuals (*Federal Register*, 1990). For noncarcinogens, the USEPA considers a hazard index "acceptable" if it is less than 1.0, because adverse effects to human populations would not be expected to occur. The USEPA indicates that a site that has a noncarcinogenic cumulative HI of greater than 1.0 generally warrants remedial action (USEPA, 1991c).

Chronic toxicity factors for potential carcinogens (SFs) and for noncarcinogenic chronic effects (RfDs) were discussed in detail in Section A5.0, along with supporting information (available IRIS summaries for each constituent of interest may be found in Attachment IV). As discussed in Section A5.0, manganese has an RfD for food and an RfD for water; the RfD for water has been used for estimating risk for all exposures to water. Manganese was not retained as a constituent of interest in soil. Two oral RfDs were given for 1,2-dichloroethene (one value for the cis-isomer and one value for the trans-isomer). Both values for 1,2-dichloroethene were retained, and a range of hazard indices was determined for both current and future risk calculations. The HQs were summed assuming 100 percent cis-1,2-dichloroethene (to represent the "higher end" of the range of risk), and also assuming 100 percent trans-1,2-dichloroethene (to represent the "lower end" of the range of risk).

As discussed in Section 5.0 of the RI report and Section A2.6, selected surface water and groundwater samples were analyzed for total chromium and for hexavalent

chromium. The results of the chromium distribution were calculated, and the average hexavalent chromium distribution was used to estimate risks. For chromium, two RfD values were given in IRIS/HEAST, i.e., one value for the (VI) valence state and one for the (III) valence state. Similar to 1,2-dichloroethene, if the chromium distribution was unknown (i.e., for soil and sediments) both values were retained and ranges of risks were determined for both current and future risk calculations to represent lower and higher ends of the risk ranges; the estimated risks were summed assuming 100 percent hexavalent chromium (VI) or 100 percent trivalent chromium (III), respectively. In soil and sediment, chromium and 1,2-dichloroethene were often both retained as constituents of interest. When this occurred, a range of risk estimates was determined with trans-1,2-dichloroethene and chromium (III) included in the lower value, and cis-1,2-dichloroethene and chromium (VI) included in the upper value of the range.

A6.2 ESTIMATED POTENTIAL CURRENT RISKS

Chemical-specific risks associated with the media and potential receptor populations evaluated under the current scenario (see Sections A3.7 and A4.0) were calculated and summed for the specific exposure routes (e.g., incidental ingestion of surficial soil) (detailed tables may be found in Attachment VII).

For the current (and future no action) scenario, two potential receptor populations (the occupational maintenance worker and the recreational/trespasser), and three media (soil, surface water, and sediment), are relevant. Table A6-1 presents a summary of all current risk estimates associated with soils, and Table A6-2 presents a summary of all current risk estimates associated with surface water and sediment.

Measured concentrations of site constituents and potentially relevant exposure scenarios were described in detail in Sections A2.0, A3.0 and A4.0. The current and potential future populations for which potential carcinogenic risks and non-carcinogenic chronic effects are to be quantified were discussed in detail in Sections A3.7 and A4.0, and summarized in Tables A4-1, A4-2, and A4-3. Chronic daily intakes for constituents of interest were discussed in Section A4.0 and presented in Attachment VI, and toxicity factors were discussed in Section A5.0. Using this information and the current USEPA methods (USEPA, 1989a) for estimating potential risks which were described above in Section A6.1, site-specific

TABLE A6-1

SUMMARY OF POTENTIAL CURRENT RISK ESTIMATES FOR SOIL^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Area	Receptor Population	Exposure Route(s)	Noncarcinogens		Carcinogens	
			Estimated Hazard Index	Primary Contributors to Noncarcinogenic Risk Estimates (Constituent, % of Risk) ^b	Estimated Carcinogenic Risk	Primary Contributors to Carcinogenic Risk Estimates (Constituent, % of Risk) ^b
<u>I. Interim Action Area - Surficial Soils (0.0 - 0.5 feet)</u>						
	Occupational Maintenance Worker	Incidental Ingestion	0.019 -- 0.24 ^c	Nickel (95%) -- Chromium VI (92%)	6.9E-09 ^d	Trichloroethene (100%)
		Inhalation of Vapors and Particulates	0.0021	Ethyl benzene (52%) and Toluene (48%)	2.2E-06	Trichloroethene (100%)
		Dermal Contact	0.0023 -- 0.028 ^c	Nickel (91%) -- Chromium VI (93%)	8.0E-09	Trichloroethene (100%)
		Total:	0.023 -- 0.27 ^c		2.2E-06	
<u>II. Remainder of Soils - Surficial Soils (0.0 - 0.5 feet)</u>						
	Occupational Maintenance Worker	Incidental Ingestion	0.00047 -- 0.0035 ^c	Nickel (72%) -- Chromium VI (86%)	1.2E-11	Trichloroethene (71%)
		Inhalation of Vapors and Particulates	3.6E-06 ^d	Methylene chloride (100%)	2.4E-08	Chromium VI (67%)
		Dermal Contact	0.00013 -- 0.00047 ^c	Acetone (65%) -- Chromium VI (72%)	1.4E-11	Trichloroethene (70%)
		Total:	0.0006 -- 0.004 ^c		2.4E-08	

^aAll chemical-specific risk estimates are presented in Attachment VII. Total risk estimates are rounded to two significant digits.^bThe constituent(s) which contributed most significantly to the individual route-specific risks are given as a percentage of that total risk estimate. If the constituents differed because of a calculated range, it is so noted.^cA range of hazard indices is presented to evaluate total chromium and 1,2-dichloroethene (total) as either 100 percent chromium (III) and trans-1,2-dichloroethene (lower value), or as 100 percent chromium (VI) and cis-1,2-dichloroethene (upper value) (see Section A5.0).^dScientific notation is an expression of a number as a power of ten (e.g., 6.9E-09 is equivalent to 6.9 x 10⁻⁹). All numbers less than 10⁻⁴ are expressed in scientific notation. The use of scientific notation for a hazard index which is less than 10⁻⁴ does not in any manner correlate the hazard index to a carcinogenic risk estimate.

TABLE A6-2

SUMMARY OF POTENTIAL CURRENT RISK ESTIMATES FOR SURFACE WATER AND SEDIMENT^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Area	Medium	Receptor Population	Exposure Route(s)	Noncarcinogens		Carcinogens	
				Estimated Hazard Index	Primary Contributors to Noncarcinogenic Risk Estimates (Constituent, % of Risk) ^b	Estimated Carcinogenic Risk	Primary Contributors to Carcinogenic Risk Estimates (Constituent, % of Risk) ^b
<u>I. Downstream Riverdale Creek</u>							
Surface Water							
		Recreational/ Trespasser	Incidental Ingestion	0.028 -- 0.030 ^c	Manganese (43-46%) and Chromium VI (37-39%) ^d	2.1E-06 ^e	Vinyl chloride (52%) and Arsenic (30%)
			Inhalation of Vapors	3.3E-05 ^e	Toluene (73%)	6.6E-06	Trichloroethene (56%) and Vinyl chloride (44%)
			Dermal Contact	0.0041 -- 0.0051 ^c	Manganese (24-29%) and cis-1,2-Dichloroethene (41-51%) ^d	1.8E-06	Vinyl chloride (40%) and Trichloroethene (32%)
			Total:	0.032 -- 0.035 ^c		1.1E-05	
Sediment							
		Recreational/ Trespasser	Dermal Contact	9.5E-06 -- 7.7E-05 ^{e,f}	Nickel (74%) -- Chromium VI (88%)	1.0E-10	Trichloroethene (68%)
			Total:	9.5E-06 -- 7.7E-05 ^{e,f}		1.0E-10	

TABLE A6-2 (Continued)

SUMMARY OF POTENTIAL CURRENT RISK ESTIMATES FOR SURFACE WATER AND SEDIMENT^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Area	Medium	Receptor Population	Exposure Route(s)	Noncarcinogens		Carcinogens	
				Estimated Hazard Index	Primary Contributors to Noncarcinogenic Risk Estimates (Constituent, % of Risk) ^b	Estimated Carcinogenic Risk	Primary Contributors to Carcinogenic Risk Estimates (Constituent, % of Risk) ^b
<u>II. Restricted On-Site</u>							
Surface Water							
	Occupational Maintenance Worker		Inhalation of Vapors	5.9E-05 ^e	Toluene (100%)	1.9E-06	Vinyl chloride (53%) and Trichloroethene (47%)
			Dermal Contact	0.024 -- 0.026 ^c	Di-n-octyl phthalate (73-79%) ^d	1.0E-06	Vinyl chloride (55%), Trichloroethene (37%)
			Total:	0.024 -- 0.026 ^c		2.9E-06	
Sediment							
	Occupational Maintenance Worker		Inhalation of Vapors	-- ^g	--	1.3E-07	Trichloroethene (100%)
			Dermal Contact	0.0043 -- 0.30 ^f	Chromium III (35%) and Antimony (28%) -- Chromium VI (100%)	7.0E-08	Bis(2-ethylhexyl)phthalate (99%)
			Total:	0.0043 -- 0.30 ^f		2.0E-07	

SUMMARY OF POTENTIAL CURRENT RISK ESTIMATES FOR SURFACE WATER AND SEDIMENT^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Area	Medium	Receptor Population	Exposure Route(s)	Noncarcinogens		Carcinogens	
				Estimated Hazard Index	Primary Contributors to Noncarcinogenic Risk Estimates (Constituent, % of Risk) ^b	Estimated Carcinogenic Risk	Primary Contributors to Carcinogenic Risk Estimates (Constituent, % of Risk) ^b
Surface Water		Occupational Maintenance Worker	Inhalation of Vapors	0.00015	Trichlorofluoromethane (100%)	2.3E-07	Carbon tetrachloride (96%)
			Dermal Contact	0.0051 -- 0.0051 ^c	Carbon tetrachloride (96-98%) ^d	1.6E-07	Carbon tetrachloride (100%)
			Total:	0.0053 -- 0.0053 ^c		3.9E-07	
Sediment		Occupational Maintenance Worker	Inhalation of Vapors	--g		--g	
			Dermal Contact	1.2E-05 -- 8.3E-04 ^e	Zinc (69%) and Chromium III (34%)--Chromium VI (99%)	--g	
			Total:	1.2E-05 -- 8.3E-04 ^e		--g	

^aAll chemical-specific risk estimates are presented in Attachment VII. Total risk estimates are rounded to two significant digits.^bThe constituent(s) which contributed most significantly to the individual route-specific risks are given as a percentage of that total risk estimate. If the constituents differed because of a calculated range, it is so noted.^cA range of hazard indices is presented to evaluate 1,2-dichloroethene (total) as either 100 percent trans-1,2-dichloroethene (lower value), or as 100 percent cis-1,2-dichloroethene (upper value) (see Section A5.0).^dBoth constituents noted contributed the greatest percentage to the total hazard index. The higher percentage noted (e.g., 46 percent manganese and 39 percent chromium VI are associated with the lower hazard index.^eScientific notation is an expression of a number as a power of ten (e.g., 2.1E-06 is equivalent to 2.1 x 10⁻⁶). All numbers less than 10⁻⁴ are expressed in scientific notation. The use of scientific notation for a hazard index which is less than 10⁻⁴ does not in any manner correlate the hazard index to a carcinogenic risk estimate.^fA range of hazard indices is presented to evaluate total chromium and 1,2-dichloroethene (total) as either 100 percent chromium (III) and trans-1,2-dichloroethene (lower value) or as 100 percent chromium (VI) and cis-1,2-dichloroethene (upper value) (see Section A5.0).^gNo risk estimate is relevant to this pathway, either because no detected constituent exhibited this type of effect, or because there were no toxicity factors for detected

risks were estimated for all relevant current and potential future receptor populations.

For the current (and future no action) scenario, the total carcinogenic risk estimates ranged from 1.0×10^{-10} (recreational/trespasser, potential exposure to sediment from downstream Riverdale Creek) to 1.1×10^{-5} (recreational/trespasser, potential exposure to surface water from downstream Riverdale Creek). The highest current carcinogenic risk estimate (1.1×10^{-5}) was principally driven by the inhalation of vapors exposure route, of which TCE and vinyl chloride were primary risk contributors (see Table A6-2).

The total noncarcinogenic hazard indices ranged from 9.5×10^{-6} (or 0.0000095) (recreational trespasser, potential exposure to downstream Riverdale Creek sediment) to 0.3 (maintenance worker, potential exposure to restricted on-site sediment (see Table A6-2). Another hazard index was very close to this maximum estimate (0.27), for the maintenance worker, potential exposure to interim action area surficial soil (see Table A6-1). The highest current hazard index (0.3) was primarily driven by the dermal contact with restricted on-site sediment route, of which chromium (III), antimony, and hexavalent chromium (VI) (depending upon the assumption used for chromium distribution) were the primary risk contributors (see Table A6-2). Also, for the next highest hazard index (0.27), the estimate was primarily driven by the incidental ingestion of surficial soil route, of which chromium (VI) was the primary risk contributor.

A6.3 ESTIMATED POTENTIAL FUTURE RISKS

Chemical-specific risks associated with the media and potential receptor populations evaluated under the future scenarios (see Section A3.7 and A4.0) were calculated and summed for the specific exposure routes (e.g., ingestion of groundwater) (detailed tables may be found in Attachment VII).

In addition to the current receptor populations, three potential receptor populations (occupational construction worker, recreational/trespasser, and residential) may be relevant under the future exposure scenarios, and four media are relevant (soil, surface water, sediment, and groundwater). Tables A6-3, A6-4, and A6-5 present

TABLE A6-3

SUMMARY OF POTENTIAL FUTURE RISK ESTIMATES FOR SOIL^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Area	Receptor Population	Exposure Route(s)	Noncarcinogens		Carcinogens	
			Estimated Hazard Index	Primary Contributors to Noncarcinogenic Risk Estimates (Constituent, % of Risk) ^b	Estimated Carcinogenic Risk	Primary Contributors to Carcinogenic Risk Estimates (Constituent, % of Risk) ^b
<u>I. Soils Under Pavement - Shallow Soils (0-8 feet)</u>						
Occupational Construction Worker		Incidental Ingestion	0.13 -- 0.15 ^c	Arsenic (87% -- 100%)	1.0E-06 ^d	Arsenic (99%)
		Inhalation of Vapors and Particulates	0.0077	Toluene (99%)	1.0E-06	Trichloroethene (100%)
		Dermal Contact	0.0016 -- 0.0018 ^c	Arsenic (94%)	1.4E-08	Arsenic (86%)
Total:			0.14 -- 0.16 ^c		2.0E-06	
<u>II. Remainder of Soils - Surficial Soils (0-0.5 feet)</u>						
Recreational/Trespasser		Incidental Ingestion	0.0012 -- 0.0086 ^c	Nickel (71%) -- Chromium VI (86%)	3.7E-11	Trichloroethene (68%)
		Inhalation of Vapors and Particulates	6.0E-06 ^d	Methylene chloride (100%)	4.2E-08	Chromium VI (60%)
		Dermal Contact	0.00013 -- 0.00047 ^c	Acetone (63%) -- Chromium VI (72%)	1.6E-11	Trichloroethene (69%)
Total:			0.0013 -- 0.0091 ^c		4.2E-08	

TABLE A6-3 (Continued)

SUMMARY OF POTENTIAL FUTURE RISK ESTIMATES FOR SOIL^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Area	Receptor Population	Exposure Route(s)	Noncarcinogens		Carcinogens	
			Estimated Hazard Index	Primary Contributors to Noncarcinogenic Risk Estimates (Constituent, % of Risk) ^b	Estimated Carcinogenic Risk	Primary Contributors to Carcinogenic Risk Estimates (Constituent, % of Risk) ^b
<u>II. Remainder of Soils - Surficial Soils (0-0.5 feet) (continued)</u>						
Residential		Incidental Ingestion	0.018 -- 0.13 ^c	Nickel (72%) -- Chromium VI (85%)	5.4E-10	Trichloroethene (69%)
		Inhalation of Vapors and Particulates	1.7E-05 ^d	Methylene chloride (100%)	2.4E-07	Chromium VI (79%)
		Dermal Contact	0.0010 -- 0.0036 ^c	Acetone (64%) -- Chromium VI (72%)	1.3E-10	Trichloroethene (69%)
		Total:	0.019 -- 0.13 ^c		2.4E-07	
<u>III. Remainder of Soils - Shallow Soils (0-8 feet)</u>						
Occupational Construction Worker		Incidental Ingestion	0.017 -- 0.051 ^c	Nickel (71%) -- Chromium VI (67%)	2.5E-11	Trichloroethene (68%)
		Inhalation of Vapors and Particulates	5.7E-05 ^d	Methylene chloride (100%)	6.7E-09	Trichloroethene (60%)
		Dermal Contact	0.00058 -- 0.001 ^c	Acetone (72%) -- Chromium VI (42%)	2.9E-12	Trichloroethene (70%)
		Total:	0.018 -- 0.052 ^c		6.7E-09	

^aAll chemical-specific risk estimates are presented in Attachment VII. Total risk estimates are rounded to two significant digits.^bThe constituent(s) which contributed most significantly to the individual route-specific risks are given as a percentage of that total risk estimate. If the constituents differed because of a calculated range, it is so noted.^cA range of hazard indices is presented to evaluate total chromium and 1,2-dichloroethene (total) as either 100 percent chromium (III) and trans-1,2-dichloroethene (lower value) or as 100 percent chromium (VI) and cis-1,2-dichloroethene (upper value) (see Section A5.0).^dScientific notation is an expression of a number as a power of ten (e.g., 1.0E-06 is equivalent to 1.0x10⁻⁶). All numbers less than 10⁻⁴ are expressed in scientific notation. The use of scientific notation for a hazard index which is less than 10⁻⁴ does not in any manner correlate the hazard index to a carcinogenic risk estimate.

TABLE A6-4

SUMMARY OF POTENTIAL FUTURE RISK ESTIMATES FOR SURFACE WATER AND SEDIMENT^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Area	Medium	Receptor Population	Exposure Route(s)	Noncarcinogens		Carcinogens	
				Estimated Hazard Index	Primary Contributors to Noncarcinogenic Risk Estimates (Constituent, % of Risk) ^b	Estimated Carcinogenic Risk	Primary Contributors to Carcinogenic Risk Estimates (Constituent, % of Risk) ^b
<u>I. Restricted On-Site</u>							
Surface Water							
	Recreational/ Trespasser		Incidental Ingestion	0.014 -- 0.015 ^c	Chromium VI (73-79%) ^d	7.2E-07 ^e	Vinyl chloride (79%)
			Inhalation of Vapors	7.5E-05 ^e	Toluene (100%)	3.0E-06	Vinyl chloride (53%), Trichloroethene (47%)
			Dermal Contact	0.011 -- 0.012 ^c	Di-n-octyl phthalate (75-82%) ^d	6.0E-07	Vinyl chloride (63%)
			Total:	0.025 -- 0.027 ^c		4.3E-06	
Sediment							
	Recreational/ Trespasser		Dermal Contact	0.0043 -- 0.3 ^f	Chromium III (35%) and Antimony (28%) -- Chromium VI (100%)	8.1E-08	Bis(2-ethylhexyl)phthalate (99%)
			Total:	0.0043 -- 0.3		8.1E-08	

TABLE A6-4 (Continued)

SUMMARY OF POTENTIAL FUTURE RISK ESTIMATES FOR SURFACE WATER AND SEDIMENT^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Area	Medium	Receptor Population	Exposure Route(s)	Noncarcinogens		Carcinogens	
				Estimated Hazard Index	Primary Contributors to Noncarcinogenic Risk Estimates (Constituent, % of Risk) ^b	Estimated Carcinogenic Risk	Primary Contributors to Carcinogenic Risk Estimates (Constituent, % of Risk) ^b
<u>II. Site Ditches and Swamp</u>	Surface Water	Recreational/ Trespasser	Incidental Ingestion	0.0016 --	0.0016 ^c Carbon tetrachloride (75%)	5.0E-08	Carbon tetrachloride (96%)
			Inhalation of Vapors	0.00019	Trichlorofluoromethane (100%)	3.4E-07	Carbon tetrachloride (97%)
			Dermal Contact	0.0025 --	0.0025 ^c Carbon tetrachloride (96%)	9.7E-08	Carbon tetrachloride (98%)
			Total:	0.0043 --	0.0043 ^c	4.9E-07	
Sediment		Recreational/ Trespasser	Dermal Contact	1.2E-05 --	8.1E-04 ^e Chromium III (33%) and Zinc (69%)--Chromium VI (99%)	--g	
			Total:	1.2E-05	8.1E-04 ^e	--g	

^aIndividual risks tables are presented in Attachment VII. Total risk estimates are rounded to two significant digits.^bThe constituent(s) which contributed not significantly to the individual route-specific risks are given as a percentage of that total risk estimate. If the constituents differed because of a calculated range, it is so noted.^cA range of hazard indices are presented to indicate the evaluation of 1,2-dichloroethene (total) as either 100 percent trans-1,2-dichloroethene (lower value), or as 100 percent cis-1,2-dichloroethene (upper value) (see Section A5.0).^dThe constituents noted contributed the greatest percentage to the lowest hazard index (highest percentage) and highest hazard index (lowest percentage).^eScientific notation is an expression of a number as a power of ten (e.g., 7.2E-07 is equivalent to 7.2x10⁻⁷). All numbers less than 10⁻⁴ are expressed in scientific notation. The use of scientific notation for a hazard index which is less than 10⁻⁴ does not in any manner correlate the hazard index to a carcinogenic risk estimate.^fA range of hazard indices are presented to indicate the evaluation of total chromium and 1,2-dichloroethene (total) as either 100 percent chromium (III) and trans-1,2-dichloroethene (lower value), or as 100 percent chromium (VI) and cis-1,2-dichloroethene (upper value) (see Section A5.0).^gNo risk estimate is relevant to this pathway, either because no detected constituent exhibited this type of effect, or because there were no toxicity factors for detected constituents. See Attachment VII.

TABLE A6-5

SUMMARY OF POTENTIAL FUTURE RISK ESTIMATES FOR THE UPPERMOST GROUNDWATER^aRANDALL TEXTRON PLANT
GRENADA, MISSISSIPPI

Receptor Population	Exposure Route(s)	Noncarcinogens		Carcinogens	
		Estimated Hazard Index	Primary Contributors to Noncarcinogenic Risk Estimates (Constituent, % of Risk) ^b	Estimated Carcinogenic Risk	Primary Contributors to Carcinogenic Risk Estimates (Constituent, % of Risk) ^b
Residential	Incidental Ingestion	310 -- 590 ^c	trans-1,2-Dichloroethene (90%) -- cis-1,2-Dichloroethene (95%)	1.9	Vinyl chloride (95%)
	Inhalation of Vapors	1.2	Toluene (100%)	0.02	Vinyl chloride (75%)
	Dermal Contact	9.2 -- 16 ^c	trans-1,2-Dichloroethene (76%) -- cis-1,2-Dichloroethene (88%)	0.039	Vinyl chloride (87%)
	Total:	320 -- 607 ^c		2.0	

^aAll chemical-specific risk estimates are presented in Attachment VII. Total risk estimates are rounded to two significant digits.

^bThe constituent(s) which contributed most significantly to the individual route-specific risks are given as a percentage of that total risk estimate. If the constituents differed because of a calculated range, it is so noted.

^cA range of hazard indices is presented to evaluate 1,2-dichloroethene (total) as either 100 percent trans-1,2-dichloroethene (lower value), or as 100 percent cis-1,2-dichloroethene (upper value) (see Section A5.0).

summaries of all potential future risk estimates for soil, surface water and sediment, and groundwater, respectively.

For the future scenarios, total carcinogenic risk estimates ranged from 6.7×10^{-9} (occupational construction worker potential exposure to remainder of soils, 0 to 8 feet) to 2.0 (residential child/adult, potential exposure to groundwater from the uppermost aquifer). The highest total carcinogenic risk estimate (2.0) was primarily driven by the incidental ingestion exposure route, of which vinyl chloride was the primary risk contributor.

The total noncarcinogenic hazard indices for the future scenarios ranged from 1.2×10^{-5} (or 0.000012) (recreational/trespasser, potential exposure to sediment from site ditches and swamp) to 607 (residential child/adult, potential exposure to groundwater from the uppermost aquifer). The highest noncarcinogenic hazard index (607) was primarily driven by the incidental ingestion exposure route, of which 1,2-dichloroethene was the primary risk contributor.

A6.4 SUMMARY AND COMPARISON TO ACCEPTABLE RISK LEVELS

In general, the current carcinogenic and noncarcinogenic risk estimates and potential future risk estimates were similar, with the exception of risk estimates associated with the uppermost groundwater. Also, with the exception of potential future risks associated with groundwater, for which ingestion was the worst exposure route, the exposure route typically associated with the highest carcinogenic risk estimates was the inhalation route. TCE, vinyl chloride, toluene, and 1,2-dichloroethene were usually the primary contributors to the inhalation risk estimates.

Considering all of the total **current** estimated carcinogenic risks and noncarcinogenic hazard indices, all carcinogenic estimates were within or below USEPA's acceptable carcinogenic risk range (10^{-6} to 10^{-4}), and all noncarcinogenic estimates were less than the acceptable hazard index (1.0).

Considering all of the total estimated carcinogenic risks for the **future** scenarios, only the residential groundwater estimate (2.0) resulted in a level which exceeded the upper limit of USEPA's acceptable range (1×10^{-4}). Also, the only total

noncarcinogenic hazard index which exceeded USEPA's acceptable limit of 1.0 was residential groundwater exposures (607).

With the exception of the two groundwater estimates noted above, all of the remaining total current and future noncarcinogenic hazard indices were below USEPA's acceptable level of 1.0. In addition, only five remaining total current and future carcinogenic risk estimates exceeded the USEPA's point of departure of 10^{-6} . These included (in descending order):

- Current downstream Riverdale Creek surface water (1.1×10^{-5})
- Future restricted on-site surface water (4.3×10^{-6})
- Current restricted on-site surface water (2.9×10^{-6})
- Current interim action area surficial soils (2.2×10^{-6})
- Future soils (0 to 8 feet) under pavement (2.0×10^{-6})

All other carcinogenic risk estimates were below the USEPA's point of departure.

A6.5 ANALYSIS OF UNCERTAINTIES

An analysis of uncertainty assists in the evaluation of the level of confidence in the quantitative risk estimates for a site. The risk methods described in the current federal risk assessment guidance are not fully probabilistic approaches to estimates of risk, but conditional estimates, given a considerable number of assumptions about exposure and toxicity (e.g., risks estimated assuming a particular future land use). Thus, it is important to specify the assumptions and uncertainties inherent in the risk assessment to place the risk estimates in proper perspective (USEPA, 1989a).

Highly quantitative statistical uncertainty analysis is usually not practical nor necessary for most site risk assessments for a number of reasons, not the least of which are the resource requirements to collect and analyze site data in such a way that the results can be presented as valid probability distributions. The current federal risk assessment guidance (USEPA, 1989a) notes that risks quantified by the

approach presented in the baseline risk assessment guidance have a relatively large degree of uncertainty associated with the numerical results (i.e., in the range of at least an order of magnitude or greater). Consequently, it is important to identify the key site-related variables and assumptions that contribute most to the uncertainty, rather than to precisely quantify the degree of uncertainty in the risk assessment (USEPA, 1989a). Therefore, in this section, only the assumptions and approaches which are expected to result in the greatest degree of uncertainty in the baseline risk assessment process and in its application to the Randall Textron plant site are described.

A6.5.1 Evaluation of Constituents of Interest and Media

The procedure for the evaluation and selection of constituents of interest at the site was presented in Section A2.0. Discussed in that section was the fact that not all of the samples were analyzed for the entire range of constituents on the TCL/TAL. It is possible that this sampling program may have led to the elimination of a constituent that may have been detected in a specific sample if that sample had been analyzed for a particular class of compounds (e.g., semivolatiles). However, as the sampling program was extensive and thorough in nature, this potential is believed to be minimal.

Through the blank evaluation and comparison to background selection processes conducted in the RI (see Section 5.0 of the RI report), a subset of constituents was selected from the range of all constituents detected in the site media. The only additional selection process utilized in the risk assessment was the evaluation of constituents with respect to frequency of detection in each medium; a five percent frequency of detection criterion was used to eliminate infrequently detected constituents and focus the baseline risk assessment on the primary constituents of interest (see Section A2.0). This selection of a subset of constituents of interest at the site may potentially underestimate risk.

Media at the site were subdivided according to relationship to known source areas (soils), ability to access (surface water and sediment), and impacted aquifer (uppermost groundwater). For surface water and sediment this often resulted in databases with relatively few data points (e.g., six samples represent surface water from the site ditches and swamp). The determination of the upper 95th percent

confidence limit (UCL) based on a relatively few number of samples will often result in a UCL which exceeds the maximum detection. When this occurs, the maximum detection is used as the exposure point concentration in the intake equation. This may potentially lead to the overestimation of risk associated with that constituent.

The UCL may also exceed the maximum detection when there is a wide range of concentrations which results in a large standard deviation. This occurred with 1,2-dichloroethene (total) in groundwater which had a range of detection from 0.0009 mg/L to 160 mg/L. The maximum detection of 160 mg/L was used to represent 1,2-dichloroethene (total) in groundwater, which may lead to a potential overestimation of risk.

A6.5.2 Toxicity Factors

The use of toxicity factors, many of which are based exclusively on animal studies, leads to uncertainty in estimation of potential risks to humans because of differences in body weight, surface area, life span, metabolism, and other factors. Furthermore, all toxicity factors available are used in the risk assessment process, regardless of the associated weight of evidence. For example, there is no adjustment in risk estimates calculated using factors for a class "A" (human) carcinogen versus a class "C" (possible human) carcinogen. There are four constituents, 1,1-dichloroethene, isophorone, 1,1,2,2-tetrachloroethane, and 1,1,2-trichloroethane that are class "C" carcinogens. Since these constituents have numerical slope factors, the risks associated with these constituents have been quantified. However, as these constituents have only limited evidence of carcinogenicity, their quantification may lead to an overestimation of carcinogenic risk.

The methods used to derive SFs and RfDs as presented in IRIS and the HEAST are inherently conservative, and would tend to overestimate risks. However, toxicity factors are not available for all constituents, and were not available for some of the constituents of interest at the Randall Textron plant. The selection of constituents for evaluation in Section A2.0 resulted in the retention of seven constituents that do not currently have associated toxicity values. Of the 51 constituents of interest evaluated, seven constituents (aluminum, iron, lead, 2-methylnaphthalene, naphthalene, phenanthrene, and 1,1,1-trichloroethane) did not have a current SF or RfD value listed in either IRIS or the latest available HEAST at the time of this

investigation. Since these constituents could not be quantitatively evaluated, this may potentially lead to the underestimation of risk.

TCE, one of the primary constituents of interest at the site, does not have toxicity values available in the latest IRIS database or HEAST. USEPA Region IV guidance indicates that the toxicity information for TCE was pulled due to a controversy over the weight of evidence classification. For purposes of the quantification of risks associated with TCE, a "B2" weight of evidence has been assumed. In addition, the USEPA Region IV recommended guidance on slope factors for TCE (see Attachment V) has been incorporated. As these numbers do not have current nationwide acceptance and may be subject to change, this may potentially lead to the overestimation or underestimation of risk associated with TCE.

As discussed in Section A2.6 and A5.0, the distribution of hexavalent (VI) and trivalent (III) chromium was assumed in groundwater and surface water, based on measured hexavalent chromium concentrations. This was done because toxicity values are not available for chromium (total). In addition, the distribution of chromium (III) and chromium (VI) determined for the surface water from the site ditches was assumed to represent the chromium distribution in surface water from the swamp, sludge lagoon, and outfall ditch. It is unknown what potential impact the assumption of a chromium distribution had on risks associated with groundwater and surface water.

Hexavalent chromium was not analyzed for in soil and sediment, therefore a range of risks was evaluated assuming 100 percent chromium (III) and 100 percent chromium (VI). However, chromium would not be present at 100 percent of either form under natural conditions. Therefore, the risk estimates for soil and sediment that are associated with chromium (VI) are overly conservative and overestimate the potential risk of chromium (total). This same evaluation also applies to 1,2-dichloroethene (total) which, as only toxicity information for the cis- and trans-isomers was available, was evaluated as a range of 100 percent trans-1,2-dichloroethene and 100 percent cis-1,2-dichloroethene in all relevant media.

When both chromium (total) and 1,2-dichloroethene (total) were retained as constituents of interest in soil or sediment, risks were evaluated as a range of risk for chromium (III) and trans-1,2-dichloroethene (lower value) and for chromium (VI)

and cis-1,2-dichloroethene (upper value). This range results in an approximate order of magnitude difference in combined risk estimates.

A6.5.3 Exposure Assumptions

One part of a risk assessment which contains several areas of uncertainty is the exposure assessment. Often the exposure assumptions that must be used to assist in the quantification of potential risk are speculative in nature. For the baseline risk assessment for the Randall Textron plant, several exposure assumptions were used that contributed to the uncertainty associated with the risk estimates.

Conservative values were utilized for many of the parameters used to determine intakes. This included such parameters as exposure frequency, exposure duration, body weight, etc., (see Section A4.0). In addition, the upper 95th percent confidence limits on the arithmetic average constituent concentrations assuming a lognormal distribution of data were used to determine intakes. The upper 95th percent confidence limit values are inherently conservative, and their use, in conjunction with the other conservative exposure parameters, may potentially result in the overestimation of risk associated with media from the Randall Textron plant. Indeed, it is possible that the analytical results for a single sample may be the controlling factor in the risk estimate.

With regard to the estimates of potential risk presented by soils, an approach was used which assumed that the risks to certain populations (e.g., the future construction worker) expected to be exposed to soils at depth could be represented by all soils from 0 to 8 feet in depth. As it is unknown to which portions of the soil column these populations would actually be exposed, this approach was determined to be conservative, and most likely results in an overestimation of the actual risks posed by soil exposures at depth.

In addition to conservative exposure values, uncertainty is also associated with the future scenarios that are addressed. The assumption that the risks associated with the current (and future no action) scenarios will be the same may, in fact, not be true. It is not certain what impact this assumption may have on risk estimates, (i.e., it is unclear whether this would result in an overestimation or underestimation of risk). Although all future scenarios are speculative in nature and add some

degree of uncertainty to the risk assessment, it is likely that the area of the Randall Textron plant will remain industrial in the future. The evaluation of the future residential scenario is considered a very conservative evaluation of potential future risks. The evaluation of the current maintenance worker is also considered conservative as there is actually very little outdoor work occurring at the site.

A6.5.4 Air Concentration Modeling

The estimation of airborne concentrations involved a number of assumptions which are conservative in nature. The effect of temperature was not accounted for in the calculation of the volatilization factor (VF). As temperature decreases the tendency of the constituents to volatilize decreases. The calculation was performed for a temperature of 25°C; however the normal average annual temperature of the site is 17.6°C (63.6°F). Only during the summer months of June, July, and August does the average monthly temperature exceed 25°C (see Section 4.6 of the RI report). Thus, the estimates of airborne concentrations most likely overestimate the volatilization potential, and thus overestimate risks. The calculation of particulate emission factors (PEF) does not take into account the possibility of the retarding effect of precipitation on the particulate emissions. During March and April precipitation is at a maximum, thereby reducing potential emissions. These considerations are in addition to the conservatism built in the model used to calculate particulate emissions, and most likely overestimate risks associated with the air pathway. The lack of inhalation RfDs and SFs for several of the constituents of interest for the air pathway is a potential source of uncertainty which may lead to the underestimation of risks associated with the air pathway.

A6.5.5 Risk Assessment Methodology

There are several sources of uncertainty inherent in the currently recognized methodology for conducting baseline risk assessments. Included within these sources of uncertainty are those which may **overestimate** risk. These include the following:

- Assumption of future development (residential or industrial) at the site

- The use of nondetectable data in calculating data statistics (including 95th percent values)
- The use of one-half the detection limit to represent nondetect data
- The use of the upper 95th confidence limits to estimate exposure concentrations
- The use of IRIS and HEAST toxicity factors which have inherently conservative assumptions and safety factors and are often based upon the use of animal toxicity data
- The use of all IRIS or HEAST toxicity factors, regardless of weight of evidence
- The use of slope factors which reflect the upper 95th percent confidence limit of the probability of response in conjunction with the use of the calculated intakes (which were in turn based upon upper 95th percent values)
- The assumption that concentrations of constituents will remain constant in the future
- The assumption of additivity of chemical-specific and multiple pathway risk
- The evaluation of both carcinogenic and noncarcinogenic effects for the same constituent
- Conservative values used for many intake variables (exposure frequency, duration, body weight, etc.)

There are also assumptions that have been employed which may potentially **underestimate** potential risks:

- Use of 95th percent upper confidence limit on the arithmetic average values to estimate concentrations for intake calculations (5 percent probability that risks would be underestimated)
- A subset of constituents were selected from the range of constituents detected in all media (i.e., the screening of constituents of interest)
- Soils greater than eight feet in depth were not evaluated
- Constituents currently without toxicity factors in IRIS or HEAST were not quantified

In addition to those sources which may potentially overestimate or underestimate risks, there are also sources of uncertainty which have impacts to potential risks that are **unknown**. These include the following:

- The grouping of site media into different areas to evaluate potential release mechanisms
- The use of dermal absorption factors
- Use of water permeability constant for some constituents for dermal (water) exposure
- Use of default parameters in the estimation of air concentrations based on the soil and sediment media
- Use of the "K" factor to convert VOC concentrations in surface water to airborne concentrations
- Use of professional judgments for potential exposure frequency and duration parameters
- The assumption of no antagonistic and no synergistic effects
- The assumption of the distribution of total hexavalent chromium

- The presentation of risk estimates including 1,2-dichloroethene as either 100 percent cis-1,2-dichloroethene or 100 percent trans-1,2-dichloroethene

On balance, it is expected that this risk estimate document tends to overestimate potential risks and is, therefore, consistent with the tendencies of regulatory agencies to err on the side of caution.

A6.6 CONCLUSIONS

The National Contingency Plan (NCP) distinguishes between sites which pose potential "principal" threats and those which pose only "low level" threats. The USEPA Superfund document "A Guide to Principal Threat and Low Level Threat Wastes" (USEPA, 1991d) defines "low level" threat wastes as those that "exhibit low toxicity, low mobility in the environment, or are near health-based levels" and that "present only a low risk in the event of release." The results of the Baseline Risk Assessment summarized above demonstrate that this site poses only potential "low-level" threats for all media except for the potential future use of groundwater from the uppermost aquifer as a drinking water supply.

All risks associated with the future use groundwater from the uppermost aquifer exceed the USEPA's acceptable upper limit of 10^{-4} for carcinogenic risks and the acceptable level of 1.0 for noncarcinogenic risks (see Table A6-5). Evaluation of the groundwater risk estimates (particularly ingestion) indicates that the high risk estimates are primarily a function of the relatively high constituent concentrations (e.g., TCE and 1,2-dichloroethene), and also a function of the toxicity of the detected constituents (e.g., arsenic and vinyl chloride). It must be emphasized that there are no known current human receptors to site-impacted groundwater. There are no groundwater wells on the site that are located in the uppermost aquifer and there are no known wells located southwest of the site (before Riverdale Creek) where the groundwater plume has migrated.

As noted in Section 7.0 of the RI report and in Section A3.0, the interim action area and the former solvent storage areas are considered primary sources of site-related constituents in soils. However, the risk estimates associated with soils from these areas (i.e., surficial soils from the interim action area and shallow soils from the

former solvent storage area; see Tables A6-1 and A6-3) indicate that exposure to soils does not present high levels of risk. In addition, although there are no likely human exposures to LNAPL and DNAPL which have accumulated near the former solvent storage areas, there is believed to be a continuing source of constituents to groundwater. In addition, the soils associated with the interim action area, especially the shallow soils are serving as a source of constituents to groundwater (see Section 7.0 of the RI report). These two areas are currently undergoing interim remediation.

The carcinogenic risk estimates associated with surface water from Riverdale Creek which had the second highest total carcinogenic risk at 1.1×10^{-5} , were primarily driven by the volatile organics of TCE and vinyl chloride as well as the inorganic constituent arsenic. This carcinogenic risk estimate is within USEPA's acceptable range of 10^{-6} to 10^{-4} . Carcinogenic risk estimates associated with surface water from Riverdale Creek exceeded those for surface water from the restricted on-site locations because Riverdale Creek surface water contained approximately three times the amount of TCE and two times the amount of vinyl chloride than that detected in the restricted on-site locations. Due to the conservatism inherent in the risk estimate, exposure to Riverdale Creek surface water is not believed to result in unacceptable risk to human receptors.

Potential impacts to biota were qualitatively evaluated based on available information and site-specific observations, as described in the Ecological Assessment and Wetlands Survey (see Section 4.11 of the RI report). Furthermore, consistent with the site Work Plan, it was assumed that levels of constituents in site media which are protective of human health are also protective of the environment, so a quantitative characterization of environmental risks was not performed. It is believed that, if impacts to terrestrial or aquatic biota at or near the site were likely, the potential for these impacts would be indicated by the results of the soils, surface water, and sediment sampling efforts (see Section 5.0 of the RI report), and by the analysis of the physiochemical properties of the constituents of interest (see Section 6.1 of the RI report).

Although Riverdale Creek is not believed to be associated with unacceptable risks to human receptors, impacted groundwater at the site discharges to Riverdale Creek and constituent plumes of TCE and 1,2-dichloroethene in groundwater have spread

as far west as the point of discharge to the creek (see Section 7.0 of the RI report). In addition to the groundwater discharge, Riverdale Creek receives discharge from the outfall ditch.

A7.0 RISK-BASED ACTION LEVELS

According to the current federal Superfund risk assessment guidance (USEPA, 1989a), the first step in the remedy selection process involves developing remedial action objectives that address constituents and media of interest, potential exposure pathways, and "preliminary remediation goals", which are used, along with other criteria, to evaluate specific remedial alternatives. The RFI guidance calls these "action levels" (USEPA, 1989). In the MDEQ guidance, these goals are numerical levels, referred to as "target cleanup levels" (MDEQ, 1990). These levels may be readily available, chemical-specific standards or criteria referred to under Superfund as "ARARs", (applicable or relevant and appropriate requirements; see Section 6.0 of the RI report), or they may be risk-based concentrations. Although it is recognized that it is the responsibility of the governing Agency to make a final decision on cleanup levels, consistent with the site Work Plan, risk-based action levels are given in this section to be further evaluated in the remedy selection process.

At the time that the site Work Plan was prepared, there was no federal or regional Superfund guidance on the development or derivation of target levels. However, the current MDEQ guidance (MDEQ, 1990) and the federal RFI guidance (USEPA, 1989) do address the calculation of risk-based concentrations based on generic (not site-specific) exposure assumptions. Since the time that the Work Plan was submitted, federal Superfund guidance on the development of site-specific risk-based levels (i.e., based on the results of the baseline risk assessment) has recently been made available in a document entitled *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals)* (Part B; USEPA, 1991b). According to this document, levels that are based on the results of the baseline risk assessment must still meet the "threshold criteria" of: (1) protection of human health and the environment and (2) compliance with ARARs.

Furthermore, risk-based action levels are not intended to be final cleanup levels for the site. Rather, these levels will be considered during the remedy selection process, and may be later modified based on "balancing" and "modifying" criteria and factors relating to uncertainty, exposure, and technical feasibility (USEPA, 1991b).

Specific methodologies by which to derive risk-based levels are available in both the MDEQ guidance (MDEQ, 1990), and in the USEPA Part B guidance (USEPA, 1991a). The MDEQ guidance method for deriving risk-based levels utilizes standard, default (i.e., not site-specific) exposure parameters and assumptions and does not require the selection of a potentially exposed population. However, in the MDEQ guidance, the Responsible Party is given the option to perform a site-specific baseline risk assessment, and to use the results so that risk-based levels may be proposed based on site-specific exposure information. The MDEQ guidance indicates that the target risk level for Class A and B carcinogens should be 10^{-6} and the target risk level for Class C carcinogens should be 10^{-5} . The federal Superfund guidance references a carcinogenic risk range of 10^{-6} to 10^{-4} , and a "point of departure" of 10^{-6} . Both methods specify a target hazard index for noncarcinogens of 1.0. The federal RCRA corrective action program calls for risk objectives similar to that of the federal Superfund program.

The USEPA Part B guidance primarily utilizes site-specific exposure parameters and assumptions, and is a reflection of the state-of-the-art in deriving risk-based levels under the federal Superfund program. In addition to federal and state Superfund guidance, the USEPA Region IV has supplemental risk guidance which addresses the development of risk-based levels. The USEPA Region IV supplemental risk assessment guidance requires that the baseline risk assessment contain remediation goal options for the constituents and media of interest. The Region IV guidance further states that the health-based goals for the potential carcinogens of interest should be given as concentrations in a given medium which correspond with risk levels of 10^{-4} , 10^{-5} , and 10^{-6} ; for noncarcinogens, the concentrations should be given which correspond to hazard index values of 1.0 and 10 (USEPA Region IV, 1992).

Risk-based action levels were calculated for selected routes and the media and constituents of interest at the Randall Textron plant based upon the methodology presented in the USEPA's Part B guidance, and the site-specific information in this baseline risk assessment. In the baseline risk assessment for the Randall Textron plant, potential risks to human receptors were estimated for all media of interest, for all constituents of interest, for a variety of types of populations and exposure routes. As discussed in Section A6.0, a relative few of these estimates indicated that

potential exposure would result in unacceptable risk levels. The individual constituents which resulted in the estimation of potentially unacceptable risks (and the conditions of exposure for the estimates) are of interest to the remedy selection process, and are the focus of the determination of risk-based action levels.

To derive risk-based action levels, it is necessary to determine which constituents to calculate levels for. However, there is no information given in either the federal risk assessment or MDEQ guidance on how to make this determination. It seems reasonable that the site constituents for which action levels are calculated are those which made the most significant contributions to risk estimates, and were greater than the carcinogenic "point of departure," (10^{-6}) as presented in the baseline risk assessment. In order to determine this, it is necessary to establish: the media of interest; the populations (and specific exposure parameters) for which unacceptable cumulative risk estimates were obtained; the exposure route(s) for which unacceptable risk estimates were obtained for a given population; and which individual constituents drove the risk estimate for the exposure route (which resulted in an unacceptable cumulative risk estimate). This process is described in detail below.

The media of interest at the Randall Textron plant which may be potentially contacted by human receptors were identified as surficial soils from the interim action area; surficial and shallow soils (0 to 8 feet) from remainder of site; shallow soils (0 to 8 feet) from the area under pavement; surface water and sediment from downstream Riverdale Creek, restricted on-site surface water bodies, and the site ditches and swamp; and groundwater from the uppermost aquifer. An occupational maintenance worker and a recreational/trespasser population were evaluated for potential exposure under the current (and future no action) scenario. In addition, a residential population and a construction worker population were considered to have the potential to be exposed to constituents present in the future.

The selection of populations, routes, and constituents to be used in the determination of risk-based action levels was a three-step selection process. This process is described as follows:

Select Populations

Determine the combined risk estimates (i.e., cumulative estimates for a given population) for each medium which exceeded either the USEPA's point of departure of 1.0×10^{-6} for carcinogenic risk estimates, or the USEPA's acceptable level of 1.0 for hazard indices, utilizing risk summary Tables A6-1 through A6-5. If more than one risk estimate for the same medium (i.e., for different populations) fulfills these requirements, select the higher of the estimates.

Select Exposure Routes

Determine the percent contribution of each exposure route (e.g., dermal) to the combined risk estimate obtained in the previous step. If the route-specific contribution is greater than or equal to 10 percent of the combined risk estimate, then the corresponding population-specific and route-specific exposure parameters should be used in the calculation of the risk-based action levels.

Select Constituents

For the exposure populations and routes selected in the above two steps, determine the constituents for which risk-based action levels will be derived using the following criteria and the individual risk tables presented in Attachment VII:

- Select a constituent for evaluation if the chemical-specific carcinogenic risk is greater than or equal to 1.0×10^{-6} , or if the chemical-specific risk is greater than or equal to 10 percent of the total risk estimate for that exposure route.
- Select a constituent for evaluation if the chemical-specific hazard quotient is greater than or equal to 1.0, or if the noncarcinogenic quotient is greater than or equal to 10 percent of the total hazard index for that exposure route.

Using the above-described selection process and the information previously described in the baseline risk assessment, sediments from all surface water bodies, surface water from the site ditches and swamp, as well as the remainder of site soils,

were eliminated as media of interest. Risk-based action levels are given for the remaining media in Tables A7-1 (soil), A7-2 (surface water and sediment), and A7-3 (uppermost groundwater), and presented in Attachment VIII.

As shown in Tables A7-1, A7-2, and A7-3, proposed risk-based action levels were calculated for two constituents in soils, four constituents in surface water, and thirteen constituents in groundwater (a total of 14 different constituents). Per USEPA Region IV guidance, risk-based action levels are presented at action levels of 10^{-4} , 10^{-5} , and 10^{-6} and at target hazard indices of 1.0 and 10. Consistent with the MDEQ guidance (MDEQ, 1990), all risk-based action levels were compared to chemical and media-specific background (UTLs, where available) and the associated method detection limits (see Section A2.0).

As noted in Table A7-1, the risk-based action level for arsenic (8.3 mg/kg) for soils under pavement calculated at the 10^{-6} target risk level is less than the background soil UTL for arsenic (17.23 mg/kg). Also, shown in Table A7-1, the risk-based action levels for TCE calculated at the 10^{-5} and 10^{-6} target risk levels for interim action area soils, and at the 10^{-6} target risk level for soils under pavement are less than the medium level analysis detection limit of 130 mg/kg, but greater than the low level detection limit of 1.0 mg/kg.

As shown in Table A7-2, all of the calculated risk-based action levels for arsenic in surface water were less than the method detection limit of $5.0 \mu\text{g/L}$, and the 10^{-6} level risk-based action levels were less than the method detection limits for pentachlorophenol, and vinyl chloride.

As shown in Table A7-3, all calculated risk-based action levels for arsenic in groundwater were below the method detection limit of $5.0 \mu\text{g/L}$, and one or more risk-based action level was less than the method detection limit for 1,2-dichloroethane, 1,1-dichloroethene, and vinyl chloride. It should be noted that the groundwater risk-based action levels were intended to be applied to soluble groundwater concentrations, although comparisons to unfiltered data could be made. In addition, if comparing measured concentrations of total chromium in groundwater to these risk-based action levels for chromium, a distribution of hexavalent chromium should be applied to the measured concentrations (see Section A2.6).

TABLE A7-1

RISK-BASED ACTION LEVELS FOR SOIL (mg/kg)

Constituent	Method Detection Limit (mg/kg) ^a	Interim Action Area				Soils Under Pavement			
		Carcinogenic		Noncarcinogenic		Carcinogenic		Noncarcinogenic	
		10-4	10-5	10-6	1.0	10-4	10-5	10-6	1.0
Arsenic	0.25/0.50/0.25	--	--	--	--	830	83	8.3 ^b (17.23)*	--
Trichloroethene	1.0/130	790	79**	7.9b,**	--	2,100	210	21b,**	--

^aDetection limits varied. For trichloroethene, the first value presents the standard low level analysis detection limit; the second value presents the standard medium level analysis detection limit. For arsenic, the first value represents the August 1991 samples, the second value represents samples from November 1991 through December 1992, and the third value represents samples from May 1993.

^bPer USEPA Region IV guidance, risk-based action levels are presented at target risk levels of 10-4, 10-5, and 10-6 and at target hazard indices of 1.0 and 10. Risk-based action levels were calculated in accordance with MDEQ guidance using either a target risk of 10-5 or 10-6, depending on the weight of evidence classification associated with each potential carcinogenic constituent (i.e., 10-6 for Class A and B constituents, and 10-5 for Class C constituents). The values footnoted with a "b" represent the risk-based action levels calculated using the target risk levels for carcinogens recommended by the MDEQ.

*This risk-based action level is less than the UTL for this constituent in background samples. The value in parentheses is the background UTL.

**This risk-based action level is greater than the 1.0 mg/kg method detection limit, but less than the 130 mg/kg method detection limit.

TABLE A7-2

RISK-BASED ACTION LEVELS FOR SURFACE WATER ($\mu\text{g/L}$)

Constituent	Method Detection Limit ($\mu\text{g/L}$)	Downstream Riverdale Creek				Restricted Onsite			
		Carcinogenic		Noncarcinogenic		Carcinogenic		Noncarcinogenic	
		10-4	10-5	10-6	1.0	10-4	10-5	10-6	1.0
Arsenic	5.0	1.1*	0.11*	0.011a,*	--	--	--	--	--
Pentachlorophenol	2.0	130	13	1.3a,*	--	--	--	--	--
Trichloroethene	1.0	7,400	740	74a	--	7,400	740	74a	--
Vinyl Chloride	2.0	120	12	1.2a,*	--	120	12	1.2a,*	--

^aPer USEPA Region IV guidance, risk-based action levels are presented at target risk levels of 10⁻⁴, 10⁻⁵, and 10⁻⁶ and at target hazard indices of 1.0 and 10. Risk-based action levels were calculated in accordance with MDEQ guidance using either a target risk of 10⁻⁵ or 10⁻⁶, depending on the weight of evidence classification associated with each potential carcinogenic constituent (i.e., 10⁻⁶ for Class A and B constituents, and 10⁻⁵ for Class C constituents). The values footnoted with an "a" represent the risk-based action levels calculated using the target risk levels for carcinogens recommended by the MDEQ.

*This risk-based action level is less than the associated method detection limit.

TABLE A7-3

RISK-BASED ACTION LEVELS FOR UPPERMOST GROUNDWATER ($\mu\text{g/L}$)

Constituent	Method Detection Limit ($\mu\text{g/L}$)	Carcinogenic			Noncarcinogenic	
		10-4	10-5	10-6	1.0	10
Arsenic	5.0	3.7*	0.37*	0.037a,*	--	--
Benzene	1.0	230	23	2.3a	--	--
bis(2-Ethylhexyl)phthalate	2.0	480	48	4.8a	--	--
Chromium (VI)	2.0	--	--	--	140	1,400
4,4'-DDE	0.10	20	2.0	0.2a	--	--
1,2-Dichloroethane	1.0	74	7.4	0.74a,*	--	--
1,1-Dichloroethene	2.0	11	1.1a,*	0.11*	260	2,600
1,2-Dichloroethene (total)	1.0	--	--	--	290-570b	2,900-5,700b
Tetrachloroethene	1.0	--	--	--	290	2,900
Toluene	1.0	--	--	--	5,700	57,000
1,1,2-Trichloroethane	1.0	120	12a	1.2	--	--
Trichloroethene	1.0	610	61	6.1a	--	--
Vinyl chloride	2.0	3.5	0.35*	0.035a,*	--	--

^aPer USEPA Region IV guidance, risk-based action levels are presented at target risk levels of 10-4, 10-5, and 10-6 and at target hazard indices of 1.0 and 10. Risk-based action levels were calculated in accordance with MDEQ guidance using either a target risk of 10-5 or 10-6, depending on the weight of evidence classification associated with each potential carcinogenic constituent (i.e., 10-6 for Class A and B constituents, and 10-5 for Class C constituents). The values footnoted with an "a" represent the risk-based action levels calculated using the target risk levels for carcinogens recommended by the MDEQ.

^bThe range of risk-based action levels presented reflects the treatment of 1,2-dichloroethene (total) as either 100 percent trans-1,2-dichloroethene (higher level), or as 100 percent cis-1,2-dichloroethene (lower level).

*This risk-based action level is less than the associated method detection limit.

The apparent discrepancies in what is a "safe" level point to the conservatism in the risk assessment process. As was described previously, these risk-based action levels are not intended as final cleanup levels for the site, and will be further considered, along with chemical-specific ARARs, in the remedy selection process.

A8.0 REFERENCES

- ECKENFELDER INC., 1991. Remedial Investigation/Feasibility Study Work Plan for the On-site Landfill, Grenada, Mississippi, November 1990, revised June 1991.
- Federal Register*, 1990. "40 CFR 300, National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule, 55 *FR* 8666, March 8, 1990.
- Federal Register*, 1988. "Integrated Risk Information System (IRIS); Health Risk Assessment Guidelines," 53 *FR* 20162, June 2, 1988.
- Land, 1975. "Tables of Confidence Limits for Linear Functions of the Normal Mean and Variance."
- Mississippi Department of Environmental Quality (MDEQ), 1990. Guidance for Remediation of Uncontrolled Hazardous Substance Sites in Mississippi, Superfund Branch, Hazardous Waste Division, Office of Pollution Control, September 1990.
- Personal Communication, 1991. Telephone conversation between Ms. Sara B. Floit (ECKENFELDER INC.) and Mr. Kevin Koporec (USEPA, Region IV).
- Personal Communication, 1990. Telephone conversation between Laura A. Mahoney (ECKENFELDER INC.) and Cindy Wilbanks (Center for Environmental Research Information, IRIS User Support, USEPA), February 28, 1990.
- USEPA, 1993a. "Health Effects Assessment Summary Tables (HEAST), Annual FY-1993," OERR 9200.6-303(93-1), March 1993.
- USEPA, 1993b. "Health Effects Assessment Summary Tables (HEAST), Supplement No. 1 to the March 1993 Annual Update," OHEA ECAO-CIN-821, July 1993.
- USEPA, 1992a. *Final Guidance for Data Useability in Risk Assessment, Part A*, Publication 9285.7-09A, Office of Emergency and Remedial Response, April 1992.
- USEPA, 1992b. *Dermal Exposure Assessment: Principles and Applications*, Interim Report, EPA/600/8-91/011B, Exposure Assessment Group, Office of Health and Environmental Assessment, January 1992.
- USEPA, Region IV, 1992. Supplemental Region IV Risk Assessment Guidance, issued March 26, 1991, last revised February 11, 1992.

- USEPA, 1991a. *"Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors"*, OSWER Directive 9285.6-03, Office of Solid Waste and Emergency Response, March 1991.
- USEPA, 1991b. *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals)*, Interim Report, Publication 9285.07-01B, Office of Emergency and Remedial Response, December 1991.
- USEPA, 1991c. "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions," OSWER Directive 9355.0-30, Office of Solid Waste and Emergency Response, April 1991.
- USEPA, 1991d. "A Guide to Principal Threat and Low Level Threat Wastes", Office of Emergency and Remedial Response, Superfund Publication: 9380.3-06FS, November, 1991.
- USEPA, 1989. *RCRA Facility Investigation (RFI) Guidance Volume I: Development of an RFI Work Plan and General Considerations for RCRA Facility Investigations*, Interim Final, EPA/530/SW-89-031, Office of Solid Waste, May 1989.
- USEPA, 1989a. *Risk Assessment Guidance for Superfund - Human Health Evaluation Manual, (Part A)*, Interim Final, EPA/540/1-89/002, Office of Emergency and Remedial Response, December 1989.
- USEPA, 1989b. *Exposure Factors Handbook*, EPA/600/8-89/043, Office of Health and Environmental Assessment, July 1989.
- USEPA, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, Interim Final, EPA/540/G-89/004, Office of Emergency and Remedial Response, October 1988.